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DEAFNESS;

ITS VARIOUS CAUSES, AND THEIR SUCCESSFUL REMOVAL BY ELECTROLYSIS, &c.

BY

H. CAMPBELL, M.D.,

Licentiate of the Royal College of Physicians of London, Member of the Royal College of Surgeons of England, &c., &c.

> "In order that diseases of the ear may receive the attention their importance demands, aural medicine and surgery must endeavour to elevate itself, in a scientific and ethical point of view."—Anton von Tröltsch.

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1872.

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PREFACE.

THE treatment of Deafness and other diseases of the ear by electricity, either alone or in combination with the usual means employed by aural surgeons, has occupied my time and attention for some years past.

Looking on Deafness as the opprobrium of the profession, I hoped, by travelling out of the ordinary routine, and employing so subtle and powerful, and yet so manageable and delicate an agent, to achieve, if not entire success, such a measure of improvement as had not yet been reached in the ordinary way of practice.

I was to a certain extent led to anticipate considerable benefit to my patients from the employment of electricity, as I had long been familiar with its singular and powerful influence in removing morbid growths and deposits in almost every structure of the body; and I naturally hoped it would exercise the same alterative and absorbent influence on those morbid deposits and thickenings

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in the Ear on which 90 per cent. of all cases of Deafness depend. That these anticipations have been fully realised, the report of cases to be found in the following pages will fairly prove; and the success which has attended my labours, as well as the knowledge of what is being done in the same direction on the Continent and in America, warrant me in believing that a very reliable and potent remedy in the treatment of deafness has been found.

For the scientific principles on which my views and treatment are based, I beg to refer the reader to page 28 of this volume, to the works and contributions to medical journals of Althaus,* Brenner,† Moos,‡ Erb,§ Hagen,‖ Beard¶ and Rockwell, and to my own published papers on the subject.**

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---

* Medical Electricity. London. 1870.

† Untersuchungen und Beobachtungen, &c. Leipzig. 1869.

‡ Archives of Ophthalmology and Otology. Vol. I. No. 1. New York and Heidelberg.

§ Archives of Ophthalmology and Otology. Vol. I. No. 2. New York and Heidelberg.

‖ Praktische Beiträge zur Ohrenheilkunde. Leipzig. 1866.

¶ Medical and Surgical Electricity. New York. 1871.

** Electro-Surgery. A clinical report of 24 cases of Deafness successfully treated by a new method, &c., &c.

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CHAPTER I.

THE MECHANISM OF HEARING—EXTERNAL AND MIDDLE EAR.

In order the better to understand the following, it may be as well to inform the general and remind the professional reader that the hearing apparatus in man consists of two distinct mechanisms, the conducting and the perceptive.

The conducting commences at the external ear, the form of which and its inclination in relation to the head have a certain influence on the acuteness of hearing. From its lower part, the auditory canal begins; along this canal the vibrations of the air are conveyed to the membrane of the tympanum, which, stretched in an oblique direction across its inner extremity, closes it.

The inner side of the tympanic membrane or drum-head forms the outer boundary of the drum proper, or as it is usually called, the cavity of the tympanum; this is an irregular cavity of not greater capacity than the empty shell of a hazel nut. In it are contained the chain of little bones or ossicles which convey the vibrations from the drum to the auditory nerve, and the two minute muscles which control them; from it the Eustachian tube passes, and ends in a small trumpet-shaped mouth at the back of the throat. The mastoid cells also communicate with it. These various parts form the middle ear, and complete the mechanism of conduction.

The membrane lining the auditory canal is a thin and delicate skin, firmly adherent to its sides, and covering the outer surface of the drumhead; towards its external opening it is loosely covered with hairs in the adult, and more internally the ducts of the wax glands open on it. It is subject to some diseases which lessen its conducting powers and produce deafness: of these the most serious are purulent discharges and polypi, the latter of which often give rise to most alarming symptoms. The position of the drum-head (membrana tympani), placed as it is between the outer and middle ear, and receiving the sonorous vibrations from without, is of the utmost importance to correct hearing. In the natural condition it forms an acute angle with the lower, and an obtuse angle with the upper surfaces of the external passage,* and can scarcely be said to be stretched, as the osseous groove in which the greater portion is inserted is incomplete at its upper part; experiment has proved that this condition is the best for the propagation in *small* membranes of ordinary undulations.

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* Von Tröltsh, in measuring a large number of cases, reckons the average angle which the plane of the membrane forms with the roof of the external canal at 140°.

Deviations of position produce more or less imperfection of hearing; and these deviations are generally produced by some diseased action in the mucous lining of the drum, adhesions and contractions of which pull the drum-head out of its proper place.

The structure of the membrana tympani is somewhat complicated; and the nature of its form, position, curvature, size, colour, lustre, and transparency are of great importance in our efforts to decide the actual condition of the middle ear. The outer surface of the membrane is covered by a continuation of the lining of the external passage, greatly increased in thinness and delicacy, and forms a firm covering for its vessels and nerves; between this and the inner surface are two fibrous layers—the proper substance of the drum-head; the outer of these layers has its fibres arranged in a radiating form, the inner in a circular, and between these two layers the handle of the first of the chain of ossicles (the malleus) is inserted.

The inner lining of the membrane is a thin layer of tesselated epithelium, continuous with the mucous membrane which lines the cavity of the drum, but much thinner and more delicate; this is the most important part of the membrana tympani in its relation to conveyance of sound, as diseased action in it is one of the most usual causes of deafness, and adhesions of its mucous surface to other portions of the mucous lining of the cavity is almost a hopeless form.

The form of the membrane in health is irregularly oval, sometimes heart-shaped; it bulges slightly in its upper and anterior portion, and measures in its greatest diameter, which is from above downwards, about four lines. Its surface is irregularly curved, somewhat undulating, and shows a conical protrusion, where a portion of the first bone of the chain of ossicles presses it outwards; its colour may be termed a neutral grey ground, with tints of violet and yellowish brown upon it, the whole covered by a soft, diffused lustre. In childhood and old age the grey is deeper and duller, there is much less lustre, and the other tints are wanting. Upon the surface of the membrane, with the apex about its centre, and the base pointing downwards and forwards, may be seen a brilliant cone of light, the extent and exact form of which are governed by the curvature of the surface. In disease this luminous cone undergoes many changes in form and brilliancy, and at all times it is a valuable auxiliary in determining the position of the drum-head, and the condition of the Eustachian tube when deafness is suspected to depend on its complete or partial closure.*

The uses of the drum or tympanum can be easily understood. The air it contains counteracts the atmospheric pressure on the drum-head, which otherwise would be driven in to an extent sufficiently great to alter its healthy and useful position;

---

* *Vide* Politzer on the Membrana Tympani, translated by Mathewson and Newton. New York, 1869.

as the atmospheric pressure on it is equal to seven pounds, a corresponding force on its inner surface is required for due maintenance of position. One most important purpose of this cavity is to render the membrane free, so that its vibrations go on unchecked. It also isolates the chain of little bones in such a manner that their vibrations are kept from contact with surrounding substances, and their weakening by diffusion prevented.

Some writers assert that the air contained in it assists in the conveyance of the sonorous undulations; but this can scarcely be the case, as it has been proved by experiment that moistening the outer surface of the membrane of the tympanum immediately impairs the hearing. Now as the inner surface is constantly moist in health, it follows that the vibrations of sound are chiefly conveyed by the chain of ossicles, and not by the contained air.

The condition of the membrane lining the tympanic cavity is of great importance to healthy hearing; a congested or thickened state materially lessens the size of the cavity, and interferes with the normal movements of the ossicular chain and its muscles; while accumulations of mucus, pus, or serum, the result of diseased action, arrest and absorb the vibrations of the drum-head and the chain of ossicles, and often by their pressure against the fenestra ovalis produce that most disagreeable ailment, "tinnitus aurium," the annoyance of which is frequently more distressing to the patient than the accompanying deafness. When these accumulations became dry they deposit mucine or fibrine on the surface of the membrane and on the bodies and joints of the ossicles, producing adhesions, membranous bands, stiff joints, &c., and converting the soft, slightly moist, villous surface of the membrane, with its net-work of capillaries and absorbents, into a hard, dry, dense, unyielding tissue, more like parchment than the delicate velvety structure it supersedes.

The Eustachian tube supplies the cavity of the

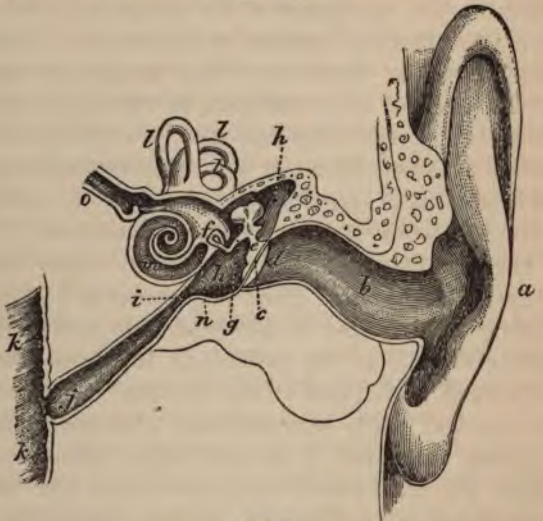


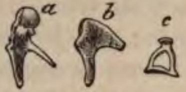
FIG. 1.

a, auricle (left ear) ; *b*, external auditory passage ; *c*, membrana tympani (section) ; *d*, insertion of membrana tympani in bony canal ; *e*, insertion of malleus in membrana tympani ; *f*, base of stapes, inserted in the fenestra ovalis ; *g*, incus, joining stapes and malleus, and completing the chain of ossicles ; *h*, cavity of the tympanum ; *i*, Eustachian opening of tympanum ; *j*, throat opening of Eustachian tube ; *k*, posterior part of throat ; *l*, semicircular canals ; *m n*, cochlea ; *o*, trunk of auditory nerve.

drum with the air required for the purposes already described; it also acts as a channel for the conveyance from it of any mucus secreted in it. This it does by the action of its vibratile cilia, which clothe its lining membrane; and by their movements in one direction the mucus is carried to the exit at the back of the throat.

It can thus be easily seen how stoppage of this tube will produce deafness: first by interfering with the balance of atmospheric pressure on both sides of the drum-head, and afterwards by allowing an accumulation of mucus in the cavity. This latter is a fruitful source of many varieties of deafness, depending on various changes which the imprisoned mucus may undergo, from simple thickening to adhesions of a more or less permanent nature.

The mastoid cells which complete the mechanism of conduction serve as a reservoir for the superfluities of air occasionally and often unexpectedly supplied to the drum, by sneezing, coughing, and other violent expulsive efforts; these, forcing air suddenly through the Eustachian tube, would cause undue pressure on the membrane of the drum did not this arrangement for receiving them exist. This is proved to be the case by the fact that accumulations of mucus in these cells, or their obliteration from disease, by lessening the capacity for storing unusual supplies of air, have resulted in rupture of the membrane of the drum in the act of violently blowing the nose, sneezing, &c. The small chain of bones contained in the cavity of the drum is next to the drum itself the most essential portion of this division of the hearing apparatus.



FIGS. 2, 3, 4.
a, malleus; *b*, incus; *c*, stapes.

This chain, composed of three minute bones or ossicles, commences in the malleus, a branch or process of which is embedded in the membrane of the drum, and its head forms a joint with a corresponding depression in the next bone, the incus; this second bone has two processes—a horizontal one, which, resting in a little hollow in the roof of the drum, forms a joint of considerable freedom of motion; and a vertical one, which articulates with the head of the third bone, the stapes. This last is of a triangular form, and bears some resemblance to a stirrup, from which it takes its name. As we have just seen, the head of this bone plays in a joint with the vertical process of the incus; but the base or foot is inserted into an opening called the fenestra ovalis, which places it in direct communication with the perceptive apparatus; and here in fact the mechanism of conduction, beginning at the outer ear, may be said to end.

It requires very little consideration to satisfy us that this little chain, composed as it is of three bones, so arranged in their articulation that they play freely on each other, starting externally from the fibrous layer of the drum-head, and ending internally in intimate connection with the labyrinth

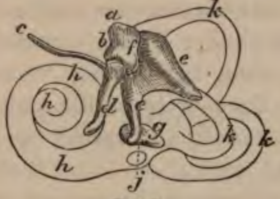


FIG. 5.

a, head of malleus; *b*, neck of malleus; *c*, long process of malleus; *d*, handle of malleus to which the tendon of the tensor muscle is attached; *e*, the incus; *f*, junction of incus and malleus; *g*, the stapes covering the fenestra ovalis; *h*, the cochlea; *j*, fenestra ovalis opening into centre of the internal ear and intermediate cavity; *k*, semicircular canals.

in which the filaments of the auditory nerve are expanded, must accurately convey all vibrations of sound from the drum-head to the perceptive nerve. In fact, the sonorous undulations in the outer air are not only carried to the inner ear by the mechanism just described without loss of intensity, but rather with increased power; and every arrangement is made to so isolate the chain in its passage from one extremity to the other that all risk of diffusion of the vibrations by contact with other bodies is avoided.

Each extremity of the chain is furnished with a small involuntary muscle, that, attached to the malleus, is called the tensor tympani; it is involuntary in its action, and when contracted causes tension of the membrane of the drum and regulates its movements, more particularly guarding it against undue relaxation, and thus preserving its vibratile power. In direct antagonism to it is the stapedius muscle, which is placed between the base of the stapes and the fenestra ovalis, at the opposite end of the chain; by its contractile power it prevents the latter bone being forced out of its position when the muscle of the malleus acts, and also assists materially in bracing up the ossicular chain.

The motion impressed upon one of these extremities is communicated to the other by a sort of see-saw movement of the little bones. If, instead of this arrangement, the chain of ossicles formed a rigid, straight line instead of an irregular and elastic one, the pressure on each extremity of it would frequently be so great as to materially, if not altogether, destroy the efficiency of the organ—a condition partially brought about by rigidity or anchylosis of the joints of the ossicles—a very common cause of deafness.

CHAPTER II.

THE INTERNAL EAR—PERCEPTIVE APPARATUS.

THE internal ear is the essential part of the hearing apparatus; in it is contained the ultimate distribution of the delicate filaments of the auditory nerve. It is called the labyrinth from the complexity of its structure, and consists of a series of chambers channelled out of the petrous bone. These are called the vestibule, semicircular canals, and cochlea; and together they form one of the most complex and delicate pieces of mechanism in the whole body.

Externally the labyrinth communicates with the cavity of the drum by two openings, the fenestræ

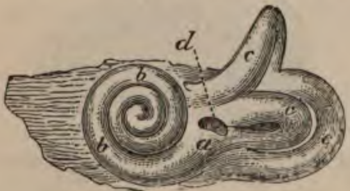


FIG. 6.

Internal ear or labyrinth, which contains the expansion of the auditory nerve (closed).

a, vestibule connecting the cochlea with the semicircular canals; *b*, the cochlea; *c*, the semicircular canals; *d*, foramen ovalis, which is covered in the natural state by the base of the stapes.

ovalis and rotunda; to the former the base of the stapes (the last link in the ossicular chain) is attached, while the latter is open, and separated from the drum only by the mucous membrane which lines that cavity.

These two openings are of the utmost importance in the mechanism of hearing. The fenestra ovalis receives the sonorous vibrations from without, and conveys the impression produced by pressure of the stapes against the fluid contained in the labyrinth, while the fenestra rotunda acts as a sort of compensating balance. In the act of hearing, the membrane covering it becomes tense like the drum-head, and receives and transmits to the labyrinthine fluid sounds of a high pitch of tone; it also checks all vibrations which might confuse correct transmission, and moderates and prevents any ill effects upon the delicate auditory filaments, by too violent undulations of sound.

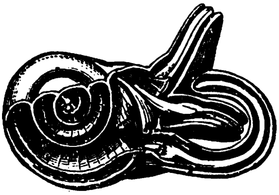


FIG. 7.
Internal ear, or labyrinth (laid open), magnified three diameters.
For description, refer to Fig. 6.

The other portions of the internal ear, of a very intricate and complicated character, are so arranged as to allow of a free distribution of the minute ultimate filaments of the auditory nerve, and to place them in the position best adapted for receiving and perceiving sound.

The auditory or acoustic nerve is of a peculiarly soft and delicate texture; it enters the internal ear through the internal auditory canal, and divides into two main branches. These, again, divide and subdivide until their ramifications become so numerous and minute that they are lost to the naked eye, and require the microscope for their investigation, with the assistance of which the existence of upwards of three thousand has been ascertained.

These delicate terminal filaments spread themselves regularly side by side over the spiral plate of the cochlea, diminishing in length from the base to the summit in such a manner, that if we suppose the spiral plate to be placed upright and forming a triangular plane, the filaments would resemble the strings of a harp, the longest at the base of the triangle, the shortest at the apex.*

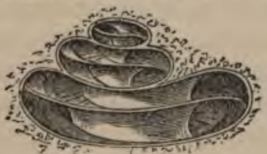


FIG. 8.
Cochlea laid open.

The auditory nerve, like the optic, may vary considerably in acuteness and discrimination in different individuals.

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* Le Pileur.

In the ear, as in the eye, the impressions made on the sensory nerve are not at once produced by the body which originates the sensation; but they are propagated through a medium capable of transmitting them.

We obviously take cognizance by the mind, therefore, not of the sonorous object, but of the condition of the auditory nerve; and all the ideas we form of sounds, as to their nature, intensity, direction, &c., must be based on the changes they produce on that organ. These changes themselves may be very much modified by error in the conducting medium, so that disease of any part of the conducting chain may materially alter or entirely suspend the vibrations given off by the sonorous object itself.

In order fully to understand the uses of the different parts of the ear just described, it is necessary to bear in mind that sounds may be propagated amongst solid or fluid bodies in three different ways—viz., by reciprocation, by resonance, and by conduction. Of all these, conduction is by far the most important, as all media, whether liquid or solid, are capable of transmitting sound in this manner.

Transmission is more rapid through solids than liquids, and through liquids than gases; and the greatest diminution in intensity of sound is usually perceived when a change takes place in the medium through which it is propagated.*

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* *Vide* "Carpenter's Physiology," edited by Dr. Power.

Sound is the vibrations of a body, transmitted to the air, and producing sonorous waves. These sonorous waves may go direct to the outer auditory passage, or first strike the outer portion of the ear, the inequalities of whose surfaces they follow, and by which they are collected and conducted to the canal, which, slightly bent on itself, transmits the sounds in curved lines, and thus modifies the shock to the membrane of the drum and enables the vibrations to be gradually transmitted to the middle and inner ear.

Experiments have proved that the irregular nature of the external ear always presents some portion of its surface at the most favourable angle for receiving sonorous waves, no matter what direction they may come from.*

The bones of the head also receive vibrations from sonorous bodies and transmit them to the external auditory canal, so that three conductors of sound supply the membrane of the drum—viz., the outer ear, the outer canal, and the bones of the cranium; of these, singular as it may seem, the vibrations of the cranial bones and the outer ear reach the tympanum before those which strike the canal alone, because solid and semi-solid bodies convey sound quicker than aeriform ones.

These sounds concentrated upon the tympanic membrane are transmitted to the chain of ossicles, which in its turn conveys them through the base of the stapes, to the fenestra ovalis, and thence by various windings to the labyrinthine fluid and the 3,000 filaments into which the auditory nerve divides.*

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* Savart.

The special functions of each of the three divisions of the labyrinth have been carefully analysed by various physiologists.

The vestibule is supposed to concentrate sound, measure its intensity and gauge its distance.

The semicircular canals determine the direction from whence the sonorous waves proceed, and consequently the position of the bodies producing them.†

The cochlea is said to be the musical portion of the hearing apparatus; it appreciates acute and articulate sounds, and perceives musical notes and voices.‡

These conclusions, though based on experiment, are more or less fanciful, but not more so than the supposition of some inquirers that the spiral plate of the cochlea, which narrows from its base to its summit, corresponds with our scale of notes from the gravest to the most acute, and vibrates in unison with each one of them.

Authors, however, generally agree in placing the principal seat of appreciation or intelligence of sound in the cochlea.§

The bearing of these observations on the various conditions and degrees of deafness will be better understood when we come to consider the causes which alter the natural and healthy state of any part of the conducting mechanism already described.

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* Muller. † Dugès. ‡ De Blainville. § Helmholtz.

CHAPTER III.

CAUSES OF DEAFNESS—THE MUCOUS.

FOR all practical purposes the causes of deafness may be divided into two great classes—the mucous and the nervous.

The mucous embraces almost all diseases of the conducting apparatus; the nervous, all affections of the perceptive.

The conducting apparatus, from its connection with external objects, and the peculiar character of its investing mucous membrane, is especially liable to disease, and morbid conditions of it are the most fruitful causes of deafness.

This membrane is so situated with respect to the mechanism of conduction, that disease, or even temporary derangement of it, will materially affect the whole apparatus. Internally it is in direct connection with the respiratory and alimentary systems; it passes from the mucous membrane of the throat and nostrils through the Eustachian tube, which it lines in its whole course, to the cavity of the drum, the sides and walls and inner surfaces of which, as well as the ossicles, their muscles and nerves, the cells of the mastoid processes, and the opening of the fenestra rotunda are covered by it. In the cavity it is thin and vascular, and covered with tesselated epithelium, as also in the osseous portion of the Eustachian tube; but in the cartilaginous portion, as it approaches the throat, it is thick, highly vascular, covered with ciliated epithelium, and studded with mucous glands.

Like all mucous membranes, it is liable to catarrhal inflammation, which, originating in any part of its course, may remain at the point first attacked, or spread over all or the greater portion of the tract.

Catarrh of this membrane, in the cavity of the tympanum, furnishes by far the greater number of cases of severe deafness that come under observation;* and although normally it is of extreme thinness, it often, in chronic cases, becomes thickened to four times its original volume, a condition which most materially interferes with its functions.

These inflammatory conditions may be so acute and rapid in their course as to give rise to most distressing and even dangerous symptoms; or so chronic and insidious, that no perceptible symptom declares itself until serious, if not irremediable, damage is effected.

Many persons suffer from deafness produced by

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* Politzer on the Membrana Tympani. Toynbee. V. Troltsch.

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chronic mucous inflammation in one ear, and are not even aware of the circumstance until some accidental change in the unaffected ear discloses the condition of the diseased one.

As inflammation may attack any part of the membrane in its extensive course, so the deafness it produces is induced in a variety of ways; but the portion most liable to initiate morbid action is that which lines the Eustachian tube, especially at its throat opening. The morbid action set up there is very liable to spread along the whole course of the tube to the middle ear, the lining of which becomes implicated in the disease; and either the condition described in a previous paragraph is induced, or the membrane pouring out mucus into the cavity of the drum arrests its functions by blocking it up.

As this lining entirely covers and invests all the various portions of the hearing apparatus on which the conduction of sonorous vibrations depends, disease of it must result in the production of deafness, the degree and curability of which will be regulated by the position and extent of the portion of membrane affected.

Mucous inflammation of the ear—or, as it is often called, "aural catarrh"—follows the law which governs inflammation of the same membrane in other situations.

When first attacked, the membrane is spongy and engorged, and its natural healthy secretion arrested; but as this condition passes off a thick, viscid, ropy mucus is secreted, which effectually blocks up the Eustachian tube when it is the seat of the disease; and when it extends to the tympanum fills its cavity, and impairs or destroys its functions. This unhealthy mucus may become absorbed, and the membrane return to its natural and healthy condition ; but in a very great number of cases that does not happen. The membrane continuing unhealthy, and its absorbent vessels congested and inert, the mucus remains unabsorbed, its thickness and viscidity increase, and a sort of semi-organisation takes place, producing adhesions in both tympanum and tube, and such an amount of immobility in the joints of the small chain of ossicles which conveys the sonorous vibrations from the drumhead to the auditory nerve, that their functions are seriously impaired or destroyed.

The drum-head itself becomes so thickened on its inner side, and so tied down by adhesions, that its power of vibration is either seriously impaired or entirely destroyed, and its *substantia propria* may be the seat of interstitial effusions forming opacities more or less circumscribed, and often ending in chalky metamorphosis.*

In a very few words we may sum up the amount of damage effected by inflammation of the mucous membrane of the ear:—

1. Complete or partial closure of the Eustachian

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* Moos. Heidelberg.

tube, whereby a due supply of air from the back of the throat to the cavity of the drum is prevented. This want of air is a serious detriment to hearing, as the atmospheric pressure on the external side of the drum-head, which is equal to a force of seven pounds, is not counterbalanced by the pressure from within; hence increased concavity of the membrane, and inability from malposition to receive the waves of sound which should strike it at a particular angle.

2. Effusion of thick, viscid, gummy mucus, containing fibrin, into the cavity of the drum and the mastoid cells, interfering with the conduction of sound to the perceptive apparatus, and frequently ending in calcareous deposits on the inner membrane.

3. Partial organisation of the non-absorbed, unhealthy, fibrinous mucus, producing adhesions of various parts of the sides and contents of the cavity to each other, and thickening and immobility of the drum-head.

4. Thickening and rigidity of the mucous lining of the cavity and the mucous covering of the ligaments, which, binding the ossicles together, form in their natural state a chain, the moveable links of which convey sound from the external ear through the middle ear to the internal, but in their stiffened and rigid state become like a solid bar, the inner end of which, instead of moving gently about with each vibration of sound received from the farther end of the chain fastened in the drum-head, and conveyed to the filaments of the auditory

nerve, is so tightly bound down that it closes up the opening into the inner ear, and impedes or completely stops the passage of all sonorous impressions.

From the foregoing, it is easy to perceive how important a part in the mechanism of hearing the mucous membrane plays, and what ravages may be produced in the ear by its chronic or acute inflammation. In fact, as already stated, the very largest proportion of cases of deafness may be traced to a diseased condition of this membrane, and, in very many instances, the unhealthy condition has gone on so slowly and insidiously, and with such an absence of discomfort to the individual attacked, that he is totally unable to say when his defective hearing commenced.

In many persons the tendency is hereditary; with such there is usually a peculiarly lax and congested state of the mucous membranes generally, which predisposes to a low inflammatory action; or, as often happens, the puffy state of the membrane lining the Eustachian tube keeps its opposite sides in such close proximity that adhesions take place, and the tube becomes closed; or, on the other hand, the areolar tissue which lies under the mucous membrane and connects it to the surrounding parts becomes implicated in the inflammatory process, and coagulable lymph is slowly effused into it. This, in time, becomes solidified, and, pressing outwards against the mucous membrane, permanently narrows or blocks up the tube, or, in other words, produces stricture. A permanent deafness of a very serious character is thus produced.

Mucous inflammation leading to deafness is generally produced by frequent attacks of sore throat, cold in the head, or ordinary catarrh; it may be induced by residence in a low and moist situation, by attacks of fever, small pox, scarlatina, measles, diphtheria, &c., or as the result of a gouty, rheumatic, or strumous constitution.

In very chronic cases, when the mischief has gone on so slowly as not to attract attention, until the damage is done, there may be no appreciable cause; but careful examination of the patient's history will almost always bring to light the fact, that the mucous membrane generally is liable to congestions, and that these may be as frequently produced by derangement of the alimentary canal as by cold. Indeed, my experience would lead me to believe, that the most treacherous forms of inflammation leading to deafness, that is, such as go on unnoticed for a very long time, have their origin in dyspepsia; and when we consider the continuity of the membrane, lining as it does the alimentary canal as well as the bronchial tubes, throat, and middle ear, we can readily understand how a diseased action, even in a remote part, may induce a generally congested condition which, although not noticeable in the larger passages and cavities, will produce a profound alteration in the capacity of such a minute tube and cavity as the Eustachian tube and tympanum.

In following up this view, it must be borne in mind that the so-called Eustachian tubes are not open in their course as our usual idea of a tube would lead us to suppose, but are long, narrow passages, the mucous sides of which are in constant contact with each other, except at such times as certain movements of the throat open their trumpet-shaped mouths and allow air to force its way along them. This close contact, in

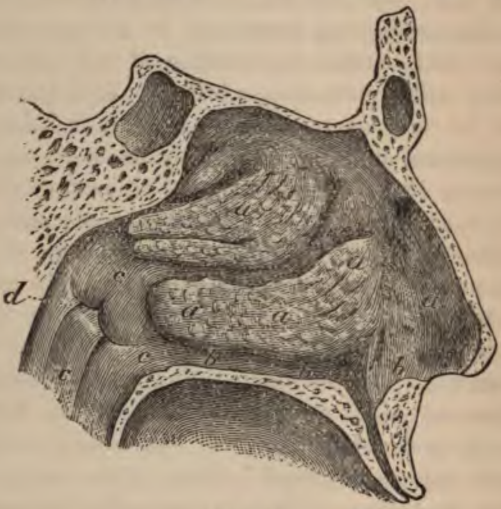

FIG. 9.

a, mucous membrane lining inner surface of nostrils (left side); *b*, lower passage of nostrils communicating with back of throat; *c*, upper part of back of throat; *d*, closed mouth of Eustachian tube in its natural state of repose.

repose, of the mucous membrane lining the Eustachian tubes is a most fertile source of deafness, which may be only temporary from congestion, as already shown, or permanent from sub-mucous inflammation and effusion.

CHAPTER IV.

MUCOUS DEAFNESS—GENERAL PRINCIPLES OF TREATMENT.

THE causes of deafness may be divided into two great classes, the mucous and the nervous. It has already been shown that acute or chronic inflammation of the mucous lining of the Eustachian tube and of the cavity of the drum produces deafness in different ways: 1st, by congestion of the membrane; 2nd, by permanent thickening of it; 3rd, by mucous accumulations in the cavity itself; 4th, by adhesions; 5th, by rigidity in the joints of the ossicles. Any one of the conditions is sufficiently grave to produce deafness; and it often happens they all exist together, as the extreme result of long-continued unarrested inflammation.

The position of the drum-head, and certain peculiarities in the method and measure of hearing still retained, assist us in forming an opinion as to the amount of mischief done to the conducting apparatus, and help us in estimating the probabilities of cure.

When the Eustachian tube is entirely closed, our difficulties in arriving at a sound opinion are very much increased, and it should be the first step in all treatment to insure a free passage through it; without such, all other treatment is useless, as it is the only channel of communication with the middle ear and its important contents.

To open the Eustachian tube and restore its functions is, then, the first step, and one which always results in a complete restoration of hearing if the diseased action has been entirely localised there; but, as often happens, the morbid condition extends into the cavity, giving rise to other states which require special attention.

Until recently, the only treatment known consisted in endeavours to force the Eustachian tube open by mechanical means, and deafness continuing after this was accomplished, the cavity of the drum was injected with various medicated lotions in hopes of softening and absorbing the unhealthy contents. Some aurists at the present day make incisions in the drum-head, and force streams of water and alkaline solutions through the middle ear in the hope of washing out mucous accumulations, while others advise the use of iodine fumigation, external counter-irritants, &c., &c.

These methods of treatment are seldom successful, as they have the radical defect of endeavouring to arrest a constitutional though morbid action by opposing a merely mechanical or local application to it. *The aim of treatment should be, not only to remove present defects where possible, but to thoroughly alter the unhealthy processes still going* *on in the mucous membrane itself;* and here I may lay it down as a rule with very rare exceptions, that a diseased action once set up in a mucous membrane never stops of itself: it goes on increasing in intensity unless arrested by a profound alteration in its nutrition. It may be easy in some cases to open an Eustachian tube, or wash out, through an artificial opening in the membrane of the drum, an accumulation of mucus; but the true treatment of deafness should not stop at this point: it should rather commence in endeavours to alter the character of the membrane itself so as to avert a return of the mischief.

To do this fully, that agent must be employed which has the greatest influence over the vasa motor nerves, blood-vessels and absorbents of a diseased mucous membrane; and none answers this purpose so certainly as the Electrolytic. This principle must not be confounded with electricity or galvanism, as generally understood. Its action is different; while they address themselves to the nervous branches and centres, Electrolysis acts chemically and vitally—chemically, it decomposes and dissolves, and thus acts on mucous accumulations and thickenings; vitally, it influences the minute circulation through a membrane, restores its absorbent system where impaired, and induces a return to the ordinary healthy standard. It has been shown how inflammation of the membrane lining the cavity of the drum frequently changes the whole character of that membrane: thus, from a soft, moist, velvety structure, it may become hard, dry, and rigid, like a piece of parchment; this condition is the result of mal-nutrition;* the process of inflammation has so lessened the calibre of the vessels as to almost obliterate them, hence the tissue perishes, because its powers of assimilation and nutrition are reduced to a minimum. Now, it is a well-established law of electricity, that its action, when applied gently, and for a short time, to any part of the body, is to increase the size of the blood-vessels in the part; this is so well marked that vessels, which in their ordinary condition require the microscope for their detection, can be so enlarged as to be plainly visible to the naked eye, while others whose calibre permits them to receive only the colourless portions of the blood, under the influence of the current, enlarge so as to receive the red globules also.† From this it may be inferred that, as the nutrition of a part depends on the supply of blood to it, any process by which the capacity of the vessels of the part to receive and carry to it the blood is increased, must of necessity improve its nutrition; and as the want of nutrition is the cause of the unhealthy condition, the consequence of increased nutrition must be improvement, and eventually restoration to its original healthy state.

Electrolysis, as just described, has been fully investigated in its effects on diseased structures in other parts of the human body; tumours with solid or fluid contents are often easily and safely removed by it; and its effects on strictured, thickened, and diseased mucous membranes in other parts of the body first led me to turn my attention to its employment in removing similar conditions in the same membrane in the human ear; for it is easy to conceive that a principle which produces such a profound alteration in a diseased urethral or lachrymal mucous membrane that all morbid action is arrested, and a healthy one set up, would, if applied to a diseased aural mucous membrane, produce the same alteration in its nutrition, and set up the same healthy action in its structure, the absence of which is fully recognised by all scientific aurists as the most fruitful cause of permanent deafness. And, let me remind the reader, that the great aural mucous tract commences in the throat and extends over the whole of the middle ear, from the mouth of the Eustachian tube to the inner surface of the drum-head; and that, as deafness may depend on diseased action in any part of it, an agent which can so certainly affect it in its whole course must be the most capable of bringing about beneficial results.

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* *Vide* page 16 *et seq.*

† Remak. Althaus. Meyer.

With respect to the immediate effect of Electrolysis, I may as well remark that any idea of pain, shock, or unpleasant sensation must not be associated with its action. It may be laid down as a general rule that a gentle current for a short time produces the greatest remedial effects, and that prolonged or powerful applications are unnecessary.* In skilled hands it may be applied to the most delicate and nervous without the least disagreeable symptoms; and, under any circumstances, no ill effects can follow its application.

In all cases of mucous deafness, except such as arise from simple closure of the Eustachian tube, the current acts more rapidly and efficiently when employed in conjunction with some weak alkaline solution. The nature of this solution will depend on the character of the aural lesion to be treated; where mucous accumulations are present in the cavity of the drum, solutions of soda and potass are indicated; they form, with the effused mucus, an emulsion which is quickly absorbed when the lining membrane is active enough of itself, or has been made so by previous preparation. In thickening of the lining membrane, dryness and diminished capacity in the cavity, anchylosis of the ossicular joints, adhesion of the base of the stapes to the fenestra ovalis, adhesions of the membrana tympani to some part of the cavity or its contents; in fact, in any case where previous effusions have become organised, and rigidity and adhesions have resulted, solutions of iodide of potass, hydrochlorate of ammonia, or of common salt, are found to answer best.

In these extreme cases I find the application of the suction tube, immediately after the current, of great assistance in breaking down the adhesions, especially those attached to the membrana tympani. The method I pursue is to apply the suction tube the moment the current ceases, the patient blowing with moderate force in the valsalvian manner during the application. The suction tube I generally employ is attached to a speculum; and I am thus enabled to examine the membrana tympani during the process, and moderate or increase the force according to the indications presented to the eye.

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* *Vide* Althan's "Medical Electricity," 1872.

In injecting the cavity of the drum, the easiest method for both patient and practitioner, and the one attended with the fewest drawbacks is that suggested by Dr. Gruber, of Vienna. The patient lays the head flat on a table, on the side to be injected, throws through the lower nostril, by means of a small indiarubber bag, about a dessert-spoonful of the solution to be used, withdraws the pipe of the bag, then, without changing his position, shuts the mouth, holds the nostrils so as to make them air-tight, and blows steadily for about thirty seconds; he is thus enabled to fill the cavity without the trouble and annoyance of an Eustachian catheter; a matter of considerable importance, as the frequent use of that instrument is to be avoided in consequence of the tendency it has to keep up considerable irritation in the nasal mucous membrane, and in the throat orifice of the Eustachian tube itself.*

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* Politzer.

When the history of the case, and the nature of the symptoms, lead to the conclusion that serum, not mucus, is present in the middle ear, injections are not indicated. In many instances the accumulation can be displaced mechanically by placing the patient's head in such a position that air forced into the cavity, with a sudden rush, will drive the fluid through the posterior wall of the tympanum into the mastoid cells, where it may be absorbed.* Should this not be successful, the continuous current, applied daily for a short time, will stimulate the absorbents to take it up.

That form of deafness in which the power of hearing is increased by the noises of a railway or other carriage, or by any act which produces powerful but slow sonorous vibrations, and which is believed to depend on a very relaxed state of the membrana tympani, and of the tensor tympani muscle which controls it, is best treated by mild applications of the interrupted or Faradaic current.

The tensor tympani muscle is an involuntary one; its duty is to pull the handle of the first bone of the ossicular chain, the malleus, inwards, and with it the membrana tympani, in which it is embedded; it thus braces up the membrane, and places it in the best position for vibratile motion, but if, as often happens, the membrane itself is so relaxed as not to vibrate to any but the most powerful sounds, this muscle, for want of due exercise, wastes, and its power of contraction becomes impaired. No treatment, save the electric, will benefit this condition; and, as the nervous power of this muscle is derived principally from the motor root of the inferior maxillary branch of the fifth pair of nerves, applications to this nerve hold out the best hopes of restoring the tone of the muscle, and improving its power of contraction.

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* Mathewson, New York, 1869.

Painting the external or dermoid layer of the membrane of the drum with a solution of tannic acid in glycerine is a useful adjunct to the Faradaic treatment, when the relaxation is extreme.

CHAPTER V.

CAUSES OF DEAFNESS—THE NERVOUS.

NERVOUS deafness, or deafness dependent on some diseased condition of the auditory nerve, either in some portion of its main or minute branches, is a less frequent disease than mucous deafness. It may be organic, affecting the substance of the nerve itself or of its investing membrane, or the delicate labyrinthine fluid in which the terminals of its minute filaments are distributed; or it may be only functional, depending on mere suspension of nervous influence. Disease in the brain at the origin of the auditory nerves induces a very formidable form of deafness, but this is scarcely within the scope of aural surgery.

Organic nervous deafness, depending on degeneration of nerve tissue, is beyond the reach of art. That which arises from inflammation of its neurilemma is more open to treatment, but that which arises from deficient nutrition, caused by the exhaustion of prolonged study, great mental strain, long continued fevers; or from suspension of function, the result of fright or shock; or from grief, anxiety, indigestion, exhaustion, over-nursing, &c., &c., is generally very amenable to treatment. In deficient nutrition, the nerve, not meeting its due supply of blood, performs its functions in a very inefficient manner, and receives with dulness the sonorous vibrations transmitted to its filaments. These cases require great attention to be paid to the general health, and also to the removal, where possible, of the conditions which gave rise to the malady. Great benefit may be expected from the daily application of gentle, continuous electric currents, which should be allowed to pass directly through the labyrinths in which the filaments of the nerves are expanded, and also through the trunks of the nerves themselves. The application should not be continued for more than from three to five minutes each time, nor repeated oftener than once a day. A steady attention to these rules, and perseverance in their application, will rarely fail to remove the most obstinate forms of nervous deafness arising from functional error. *Vide* Cases XVIII. and XIX.

Experiments on the auditory nerve, with a view to restore its function, were made by the earlier inquirers in electricity as far back as the commencement of the present century; of these the most distinguished published the results of their experiences, and, in some instances, reported cases of deafness cured by the electric current;[*] but the ignorance which then prevailed as to the many causes which give rise to various forms of deafness, added to the rude and elementary character of the instruments employed, and a want of knowledge of the different therapeutic actions to be produced, soon led to confusion, disappointment, and, finally, abandonment; and the Electro-Therapeutics of deafness passed into oblivion, or, like other branches of curative electricity, fell into the hands of the charlatan and the uneducated, who often accidentally accomplished the most brilliant cures by some unscientific and misunderstood method of application.

The renaissance of Electro-Therapeutics in nervous diseases of the ear, is due to Dr. Rudolf Brenner, of St. Petersburg. This laborious inquirer has brought great scientific skill and untiring patience to bear on this subject, and with good results. Although at first he experienced much opposition at the hands of aurists and electricians, his facts are now generally admitted to be true, and those who have followed carefully and correctly his experiments have acknowledged their trustworthiness, especially Hagen, who employed them in fifty-two cases of diseases of the ear,* and Moos, of Heidelberg, one of the most distinguished aurists in Europe, who cured a case of complete nervous deafness by the galvanic current.†

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[*] AUGUSTIN—Vom Galvanismus und dessen Anwendung. Berlin, 1801; MERZDORFF—Behandlung des Ohrensausens durch den Galvanischen Strom. 1801; FLIES—Galvano-Therapeutische Versuche. 1801; STELLWAG—Ueber Galvanismus. Hamburg, 1802; STRUWE—System der Medicinischen Elektricität, &c. 1802; WOLKE—Osnabrück. 1802; MARTENS—Therapeutische Anwendung des Galvanismus. 1803.

The principle laid down by Brenner and his followers, and borne out by their experiments, is: *That the auditory nerve in health, reacts to the galvanic current in a regular manner, by distinct sounds at and during the closing of the negative and at the opening of the positive pole; that these sounds may be whistling, ringing, hissing, singing, humming, and rumbling; that they vary in different individuals, and are modified by the strength and duration of the current; that the most frequent is whistling, which is clear, agreeable, and musical; and that any departure from these reactions indicates disease.*

To distinguish between a healthy and diseased ear by the character of the reaction, it is necessary to have a proper apparatus of not less than twenty elements, with a reversor for changing the direction of the current, a commutator for increasing or diminishing the number of elements, and a rheostate for introducing resistance into the circuit.

Ritter, experimenting on himself, notes, that when a direct continuous current was passed through his own ears, the pitch of the tone heard was G, which became higher as the intensity of the current was increased; but when an inverse current was applied, the sound produced was lower than G, and gradually sank still lower when the intensity of the current increased.

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* Praktische Berträge zur Ohrenheilkunde. Leipzig, 1866.

† Archives of Opthalmology and Otology, Vol. I., No. 2.

The conclusions which these researches lead to are, that the auditory nerve is more or less implicated in many cases of deafness dependent on changes in the drum and middle ear, and that this complication occurs not only in cases of very long standing, depending on deposits of morbid products, growths, suppurations, &c., but may also be present in recent ones, as acute catarrh, &c., &c.; and that in all such cases of muco-nervous deafness, electrical treatment is indicated.

It is a matter of much regret that so few aurists in this country have had recourse to carefully-arranged and adjusted Electro-Therapeutic treatment, so as to give the additional weight of their testimony to the labours of their continental brethren. Where it has been employed, neglect of the essentials to success has too often thrown discredit on what, if used with a due appreciation of special qualities and delicacy of manipulation, might have yielded the operator a new and potent remedy in a class of diseases very sadly wanting in such agents.*

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* For an exhaustive treatise on this subject see Drs. Beard and Rockwell's "Medical Electricity." New edition. New York, 1871. Page 546, *et seq.*

Nervous Hysterical Deafness.

This not uncommon form of deafness is the result of some peculiar morbid process going on in the nerves of audition, usually from impoverishment or exhaustion of their ultimate tissue; it may follow eruptive or continued fevers, or be induced by any exhausting or depressing cause. It has been known to follow the too free use of quinine in intermittent fever. The term hysterical is an unfortunate one, as it seems to fix the disease entirely amongst women, whereas it is common to the delicate and nervous of both sexes.

The variety of electricity best fitted for this form of deafness is the Faradaic or induced; and its curative influence seems to depend in a great measure on the excitability it produces in the chain of ossicles, and through them, by their connection with the fenestra ovalis, on the undulations of the labyrinthine fluid in which the ultimate filaments of the auditory nerve are bathed.*

Duchenne reports cases of this disease cured by the Faradaic current, and several cases of nervous deaf-muteism much improved by it. He also says that "no electric exploration of the ear furnishes pathognomonic signs which permit the prognosis of incurability of hysterical nervous deafness." †

Dr. Moos, of Heidelberg, published a case of recovery from nervous hysterical deafness, following an attack of acute rheumatism, in a young lady nineteen years of age. Before treatment, she was completely deaf for noises, musical notes, and speech, and had to be communicated with by writing. The galvanic treatment commenced on the 10th May, 1869, and was continued daily till the 27th July. On the 11th day of the treatment she heard her own voice in the left ear immediately after the application of the current; on the 24th June she noticed voices for the first time; on 12th July, two months from commencement of treatment, she could hear the watch on the right side at ten feet, on the left at nine feet; at the end of this month she was sent away for change of air, and the recovery of her hearing was complete on her return, the action originated by the current having continued after its application was withdrawn.

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* *Vide* page 15.

† De l'Électrisation Localisée, &c. Paris, 1861.

In a case of deafness of the same character (under the care of the same accomplished aurist), following an attack of cerebro-spinal meningitis, and accompanied by noises in the head, giddiness, and headache, where the right ear was totally deaf, and the left could not distinguish sounds beyond two feet, twenty-two applications of the continuous current raised the hearing power to eighteen paces, and materially diminished the noises and giddiness.*

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* Archives of Ophthalmology and Otology, Vol., II. No. 1., p. 233.

CHAPTER VI.

NOISES IN THE HEAD (*Tinnitus Aurium*).

THIS most annoying ailment, although frequently accompanying deafness, may exist without it. It commonly makes its appearance at or shortly before middle age, and, as life advances, increases in intensity. The sounds vary in different individuals, some comparing their sensations to rushing water, rustling of trees, &c., &c., while others speak of them as resembling bell-ringing, roaring of machinery, whistling, &c., &c. It is a curious fact, that the character of the sounds generally bears a strong resemblance to the ordinary sounds by which the individual is surrounded, thus persons living in country districts complain of the first class of sounds, while those inhabiting towns speak of the second. When deafness is present, and no fault can be discovered in conduction, the cause may be traced to defective circulation in the auditory nerve, the result of hæmorrhage, chlorosis, hysteria, anæmia, &c., or other exhausting and depressing diseases. If the hearing is unimpaired, the filaments of a branch of the fifth pair of nerves, which supply the drum, may be considered as implicated. In either case, gentle streams of electricity, applied to the tympanum and the cervical sympathetic nerves, and continued daily for not longer than three minutes, will generally remove the tinnitus. This method has been found successful in the hands of the scientific aurists in St. Petersburg, Vienna, Paris, and New York, as well as in some cases occurring in my own practice.*

A very common cause of tinnitus accompanied by deafness, and giving rise often to most alarming symptoms of giddiness and oppression, has for its origin accumulations of hardened and unhealthy wax in the outer meatus; this hardened mass presses against the membrane of the tympanum, and produces all the unpleasant effects of severe disease; an early and judicious removal speedily arrests the ailment, although I have known the loud and alarming noises to be followed by gentle hissing or cooing sounds, which have continued for a considerable period afterwards. Cases of this description are of every day occurrence.†

Other causes of tinnitus exist which are less simple in their origin, and give more trouble to both patient and practitioner. Of these we may mention, first, closure of the Eustachian tube; second, congestion or thickening of the membrane lining the cavity, the consequence of acute or chronic catarrh; third, accumulations of serum or mucus, or other collections within the cavity—all or any of these conditions may cause tinnitus, by the undue pressure they exercise upon the two openings from the tympanum into the labyrinth, in which latter is contained the delicate fluid through which the microscopic filaments of the auditory nerve are floating.* The treatment already laid down for the cure of mucous deafness is that best adapted for the removal of this form of tinnitus.

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* *Vide* Case XXIII.

† *Vide* Case XXIV.

Another most unpleasant symptom, often accompanying structural changes in the middle ear, may be mentioned here, viz., throbbing or beating, with or without heaviness or fulness, sometimes much increased after meals, unusual exercise, or excitement; it may arise, also, from overdoses of quinine, or the too long use of steel medicines or chalybeate springs. The sounds, usually synchronous with the sounds of the heart, arise from a distended state of the blood-vessels distributed over the lining of the cavity; the cavity itself, being empty and resonant, communicates the vibrations it receives from the vessels to the labyrinth.

The treatment for this condition, when it arises from structural causes, has been already laid down. When it is the result of overdoses of quinine or iron, it speedily subsides with the suspension of these remedies. Cases sometimes resist all treatment. These are usually the result of serious structural change in some part of the acoustic nerve itself, and happily are comparatively rare.

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* *Vide* page 11.

CHAPTER VII.

SUMMARY OF TREATMENT AND REPORT OF CASES ILLUSTRATING IT.

Of the two great classes into which the causes of deafness naturally divide themselves, the mucous, as may have been seen, occupies by far the larger and more important place; and, while mucous deafness comprises perhaps nine-tenths of all cases, it is a notable fact that of the two forms it is, as a general rule, the most amenable to treatment. Thus, from a professional point of view, it offers the largest field for practical usefulness.

Scientific inquirers into the pathology of deafness recognise the fact that the mucous form is the result of a morbid deposit of a plastic material on some part of the conducting apparatus of the ear. It may occur on either side of the tympanic membrane; in its proper substance, in the cavity of the drum, in the mastoid cells, in the ossicular chain, in some portion of the Eustachian tube, or in the sub-mucous areolar tissue, which connects the under surface of the mucous membrane with the parts it invests; but, let its position be where it may, the loss of hearing is entirely dependent on this, and its intensity is in strict proportion to the extent or importance of the portion of the great aural tract affected. No treatment can avail unless it removes this morbid deposit and restores the healthy condition of the membrane, and recovery will be partial or entire exactly as the deposit is partially or entirely removable.

The method of treatment which the following cases illustrate has for its object the absorption of this plastic material. This is effected by passing gentle streams of electricity along the course of the diseased membrane, and stimulating its absorbent vessels to take up the effused and often partially organised material. In cases of mucous accumulation in the drum, the injection of various saline solutions into the middle ear, to mix with and liquify the viscid mucus, materially assists the current in the process of restoration.

On this mixture of unhealthy mucus and medicated fluid the electric current, when properly directed, has the effect of producing "Electrolysis;" that is, it decomposes and resolves it into its original elements so that the absorbents are enabled more freely to act on and remove it. Some interesting cases of cure of this very inveterate form of deafness will be found in the following pages.

For the sake of clearness, the cases are divided into those occurring in the three great periods of life—youth, manhood, and old age; although, strictly speaking, no particular lesion can be said to belong to one period alone. It may also be mentioned that nearly all the cases had previously undergone the routine treatment usually pursued.

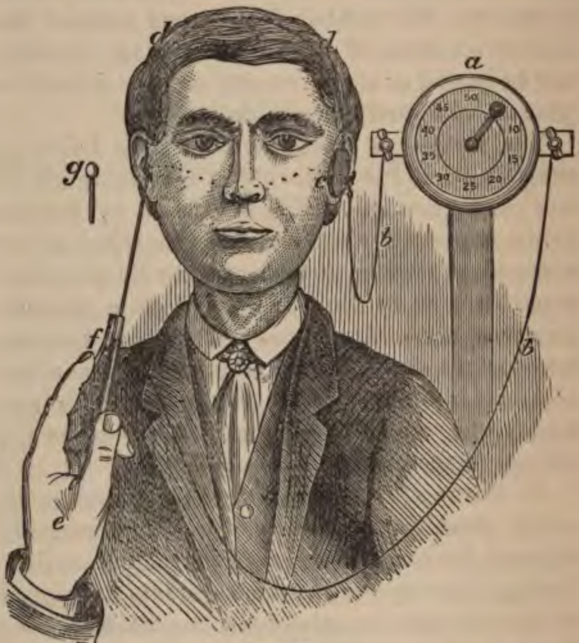

FIG. 10.

Showing the method of applying the continuous current in a case of deafness in both ears.

a, index of battery, with handle to regulate the strength; *b*, conducting cords; *c*, insulating disc, through the centre of which a metal point, covered with sponge, passes; *d*, spring supporting disc; *e*, hand of operator; *f*, conducting wand, with trigger to break the current; *g*, head of conducting wand, covered with sponge.

☞ The dotted line across face shows direction of current.

DEAFNESS IN CHILDHOOD AND YOUTH.

The deafnesses of children and young people are almost always mucous in their origin: they may arise from constitutional weakness, as in the strumous; or they may be produced in the first instance by cold, or one of the eruptic fevers, as scarlatina, small-pox, measles, diphtheria, &c. The attack generally commences in the nostrils or the back of the throat, and may extend along the course of the Eustachian tube to the cavity of the drum, producing many unhealthy changes there affecting the conduction of sound. The following is an average specimen of such cases:—

CASE I. *November 2nd,* 1870.—J. K., æt. seven years, deaf in both ears for eighteen months. He was formerly very sharp and intelligent, but since his deafness (the result of scarlatina) he has been dull and stupid; and his parents fear he will become dumb, as he is already losing the use of many words he formerly employed. There is a purulent discharge from left ear, the right is free from it. Examination proves both Eustachian tubes to be completely closed, no air enters the cavities of the drums, and the drum-heads are much displaced by external pressure; that of the left ear has an unhealthy granular appearance. I endeavoured to open the Eustachian tubes and inflate the drums in the ordinary manner by the application of Politzer's bag, but failed after some very forcible

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attempts, and desisted when I found the same plan had been repeatedly tried before without success. I then applied a very mild electric current along the track of each tube to the outer ear, giving three minutes to each; the boy made no complaint of any unpleasant symptom, and the treatment was resumed every alternate day till the 17th; by that time a very free discharge of thick, glairy unhealthy mucus from the nostrils and throat was established, from which it was evident the membrane was relaxing, and a new action being set up in it. I again endeavoured to open the Eustachian tube by the application of Politzer's bag, and succeeded at the second trial, the air rushing into the cavities of both drums and being distinctly audible through the otoscope. The hearing returned almost immediately, the boy was able to count the watch-ticks at three feet, although unable to answer questions close to him. This I attributed to confusion and want of use, his deafness having been so complete for so long a period.

From this time his hearing powers steadily increased, and as he became accustomed to voices he resumed his old intelligence and sharpness. The purulent discharge from the ear yielded to ordinary astringents, the malpositions of the membranes of the drums became rectified as the external pressure was counterbalanced by the pressure of air from within, and he may now be looked upon as permanently cured.

CASE II.* *September 5th,* 1870.—Miss R.G.B., æt. thirteen years, of fair general health, but very tall for her age, and evidently outgrowing her strength, has been deaf in her right ear for nearly a year. As her sister, now twenty-eight years old, is perfectly deaf in both ears, and her first symptoms commenced about this young lady's age, her parents are very anxious on her account.

She has been under treatment by various aurists, and the usual means to inflate the right ear, the Eustachian tube of which is entirely closed, have been frequently tried, but without success. Her hearing on that side is so defective she cannot hear a watch tick at two inches, nor understand the voice at one foot.

A gentle current of ten cells was passed from the Eustachian opening in the throat to the outer auditory passage, for five minutes, every alternate day, for a week. This was followed, after the second application, by a steady flow of thick viscid mucus from the throat and nostrils.

After the fourth application of the current, the tube had become so relaxed I was enabled, with a little mechanical assistance, to inflate the ear on the first effort, the Eustachian tube yielding at once.

The hearing immediately returned to a considerable extent. She was able to count the watch-ticks

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* This case and a few of the following have been already published elsewhere.

(the left ear being closed) at nine feet, and converse in an ordinary voice at fifteen feet.

The current was continued on alternate days for another week, when she left me with her hearing at the natural standard.

Case III. *September* 12*th*, 1870.—J. S., æt. twenty years, deaf in left ear for the last five years. Can hear the watch tick only when held close to the ear, and when the right ear is closed is unable to hear the voice at eighteen inches. Examination disclosed an unnaturally concave state of the drum, and proved the Eustachian tube on the affected side to be quite closed.

In spite of repeated and forcible attempts to open it mechanically, I was unable to produce any impression, and had to desist in consequence of profuse bleeding at the nose, evidently induced by my efforts. I then passed a gentle continuous current along the course of the tube to the outer ear, and repeated it daily for a week. By this time the membranes had become so yielding that he was enabled to inflate the tube himself by simply closing his mouth and nostrils, and steadily blowing for about one minute. In this manner the drum became supplied with air, and the extreme concavity of its membrane instantly disappeared; his power of hearing rose at once to twenty feet, at which distance he could hear the watch tick, and answer questions addressed to him in an ordinary tone.

To prevent relapse I continued the application at intervals of three days, for a month, directing him to continue the blowing night and morning.

May 12*th*, 1871.—J. S. has not been under treatment now for six months, and called to-day to give me an opportunity of examining his ear. The position and appearance of the membrane of the tympanum are quite natural. He considers himself perfectly recovered; can hear any ordinary sound at twenty-five feet, and has no symptom whatever of a return of the deafness. Altogether the ear has returned to its natural standard.

This is a very favourable case, not only as regards the ease with which the obstruction was overcome, but the rapidity with which the ear returned to its healthy state. The month's after-treatment was not indicated, but merely done as a measure of precaution, and to produce that complete change in the nutrition of the mucous membrane that all risk of return to the diseased action might be obviated.

Fortunately for him, the mischief was confined to the tube alone; had it passed into the cavity, the good result would not have been so quickly attained.

Many similar cases of relief of deafness in the young arising from the same causes might be adduced; but the foregoing are fair illustrations of the effects of Electrolysis on the congested, thickened, and diseased mucous membranes.

In obstinate cases of purulent discharges from the ears, which have defied all ordinary treatment, *such as injections, &c., Electrolysis rarely fails to effect a cure.*

Case IV. *May* 21*st*, 1870.—M. C., æt. eleven years. Very deaf in both ears with severe purulent discharge from each; had measles two years ago, and suffered much from the sequelæ, which were followed by the present symptoms. The general health is now good, but has been very delicate; various remedies have been applied to the ears to arrest the offensive discharge, but without effect. The lining of the outer auditory passage and the drum-head is in a very unhealthy state, and the whole character of its circulation and nutrition must be altered before it is restored to a natural standard.

I filled the outer ear on one side with a piece of sponge soaked in warm water, and applied to it the negative pole with a power of six cells, closing the current by placing the positive on the mastoid process of the same side. The action was kept up for ten minutes. The other ear was treated in a similar manner the following day; this course was pursued on alternate days for a fortnight; by that time a healthy action was set up in the lining membrane, and the treatment was stopped. The purulent discharge was arrested after the third application and did not return. The hearing was not improved at first, but as the absorbent action progressed and the thickening reduced, the deafness gradually passed away.

December 9*th*, 1870.—I have this day seen M. C.;

his ears are in a healthy state, with the exception of some thickening of the drum-head still left, his hearing rather less acute than the standard, but sufficiently good to allow him to follow his studies in class, with other boys. I have little doubt that at his age the thickening will be entirely removed by absorption, and his hearing should then be perfect.

Many similar or nearly similar cases could be adduced to prove the effect of Electrolysis on the diseased membranes of both the outer and middle ear.

DEAFNESS IN THE ADULT

May arise from any cause, although the predominating one lies in the mucous linings of the ear—as may be seen in the following :—

Case V. *April* 10*th*, 1870.—H. K., æt. twenty-seven years, barrister, has been deaf in both ears for the last six years. His left ear is somewhat better than the right, and with it he can hear a watch tick at eighteen inches, and converse, if the person stands in front of him, at four feet. The right ear is entirely gone; no sound addressed to it makes the least impression on it.

Examination of the left ear discloses a very concave state of the drum-head, and a partial closure of the Eustachian tube on that side. On the right side the drum-head is so pressed in as to be almost horizontal, and the Eustachian tube is entirely closed. The mucous membrane of his nostrils and throat is much congested, pale, and flabby. He speaks as if he had a cold, but says it is his usual condition, and has been so for years. Complains also of considerable singing in his head, but cannot say where it is, as it confuses him. He has been under treatment both in England and on the Continent, and, under advice, employed Politzer's bag for a considerable period; latterly he has abandoned all treatment, as he has derived benefit from none.

April 14*th.*—Have applied a current of ten cells for three minutes daily for the past week, from the upper and posterior part of the throat on the right side to the outer meatus. This has had the effect of producing a profuse flow of thick, stringy, tenacious mucus, which has evidently unloaded the congested lining of the tubes, as air can now be forced through them into the cavities of the drums without much effort.

His hearing has so far returned in the right ear, that the watch tick can be counted at eight inches, and an ordinary voice understood at four feet. The membrane of the drum is less horizontal than it was, but still in an unnatural position. Continue the Electrolysis for a fortnight.

April 28*th.*—Mucus still flowing from the throat, but less in quantity, and healthier. Hearing much improved in both ears; with the left ear plugged and the eyes shut he can sustain his share in a conversation held fifteen feet from him. His voice, which was formerly thick, muffled, and somewhat nasal, is clearer and more natural. It is quite clear his mucous membranes are taking on a much healthier action, and the danger of relapse is lessening daily. Continue the treatment for a week.

May 3rd.—He now hears fairly with both ears, and considers himself quite restored.

Case VI. *October* 12*th*, 1870.—C. F., Civil Engineer, æt. thirty-seven, has been deaf in the right ear, and slightly so in the left, for the last eight years. He is much troubled by a constant noise in both ears, which attracts his attention in spite of himself, and is a source of much annoyance.

He cannot hear the watch tick on the right side beyond one inch from the ear, nor the voice beyond a foot, the left ear being closed. He has been under treatment for his deafness almost since its commencement, and had been in the habit of injecting the drum with warm alkaline solutions until eighteen months since, when he gave it up in despair. Both Eustachian tubes are quite open, and by blowing in the Valsalvian method he is aware of considerable crackling in the cavity of the right drum. Examination with the otoscope discovers a soft mucous râle, which indicates the presence of mucus in the cavity. This has been known to be the case for years, and previous treatment, especially the alkaline injections, had been employed, though unsuccessfully, for its removal. The presence of this mucus no doubt was the principal cause of deafness, and any chance of recovery which he might have, lay in the hope of removing it. I filled the cavity of the drum with a weak solution of iodide of potass, and passed a current for three minutes through it; the negative pole being placed at the trumpet mouth of the Eustachian tube, and the positive in the outer auditory passage. This treatment was pursued daily for sixteen days, when it was evident on examination the mucus was dissolved and absorbed. The hearing had improved so far that he could count the watch tick distinctly at nine inches, and understand the voice at thirty inches. The alkaline injections were now discontinued, and gentle currents passed through the ear every alternate day with a view to induce a healthy action in the mucous lining of the cavity. After thirty applications the treatment was stopped, as the hearing had so far returned he was able to follow with ease a conversation distant twelve feet, and it was probable that the natural action now set up in the membrane would go on without Electrolytic assistance.

I have lately seen this gentleman, and he considers himself quite restored.

CASE VII. *February* 12*th,* 1870.—R. G. H., æt. forty-two years, has been deaf in both ears since his thirtieth year, when he had an attack of typhoid fever, from which he recovered with difficulty. He has been under treatment at various times, but without benefit. On examination, the membranes of the drums of both ears are found to be very much out of their proper position; and, on desiring him to blow in the Valsalvian manner, in order to inflate the cavities, no change is seen to take place, although air is known to enter freely. It is evident the lining of the middle ear is in a very thickened state, and, as a consequence, the cavity is very much reduced in size, and the drum-head is unable to convey sonorous vibrations from the condition of its inner membrane; it is also unable to receive sounds from its altered position.

Both cavities were filled every night at bedtime with a moderately strong solution of iodide of potash, and a current of fifteen cells passed through them the following morning for five minutes.

This treatment was pursued for two months; during its progress, the membranes of both drums, but especially the right, began to assume a better position, and the ability to hear returned in a slight degree. The patient complained of considerable discomfort in both ears, and a sensation as if they were stuffed with wet wool. It was considered advisable to discontinue the injections into the drums, but to persevere with the current alone. This was accordingly done daily for a fortnight, and with marked benefit. The power to hear on the right side extended to eight feet for the voice, and three feet for the watch; on the left it was a little more than half this distance. The current was now applied three days a week for another fortnight, when it was considered expedient to stop, and allow the action set up in the membranes to continue unassisted.

In the following August I had an opportunity of examining him again. The left ear continued much as I had seen it in the May previously. He could hear fairly with it at six feet, but on the right side the improvement was very much more marked. The position of the drum-head was more natural, and the hearing distance was increased to twelve feet. This is much less than the standard distance, but still enough for all practical purposes; and to a person of the degree of deafness formerly present was highly satisfactory.

Many cases of a similar description, of very long standing, do not yield to treatment as well as the above; but if persevered with long enough, a certain measure of hearing is usually obtained, unless very obstinate adhesions exist; when this is the case I fear no treatment will avail.

The next is a very interesting and instructive case of mucous deafness arising from a very diseased state of the lining of both drum cavities.

CASE VIII. *February 28th*, 1870.—J. R. K., æt. fifty-two years, a married lady, has been deaf in both ears for upwards of ten years. She can sustain a conversation with difficulty if the voice be within six inches of her, but cannot hear a watch, even when pressed against her ears. She has been under treatment at the hands of various aurists, and, in the early part of this year, had the drum-head on the left side cut at three different periods, and injections of various medicated solutions forced through the ear. No good result followed, but an increase of deafness instead. The auditory nerve on each side is quite healthy, air enters the tubes, but produces no effect on the membrane of the drum; and it is clear the lining of the cavities and their contents are in a thickened and unhealthy condition. I had both cavities filled through the Eustachian tubes with a weak solution of iodide of potash, and passed a current of fifteen cells through each ear for five minutes. She bore this well, and I suggested its repetition daily for a fortnight.

March 13*th*.—Hearing not improved. Continue the treatment.

March 24*th*.—Hearing improving. Can hear her watch at four inches, and the voice at eighteen inches, but complains of fulness in both ears, and some discomfort. Discontinue the injections into the middle ears, and apply the current alone every alternate day for the present, but only for three minutes each time.

April 16*th*. — Hearing continued to improve until the 4th instant, when she had a severe attack of influenza, which brought a renewal of her deafness. The influenza has passed off, but she is still very deaf. Return to the injections and Electrolysis.

July 21*st*, 1870.—The treatment has been continued at short intervals to the present time. Her hearing fluctuated a good deal until about a month since, when the improvement then made seems to have become permanent. She now hears the watch tick at about two feet from her, and can follow a conversation with ease at a distance of nine feet. She is so content with the measure of hearing obtained that she considers herself cured.

The amount of hearing recovered in this case was much below the full standard, but still so considerable that the patient deemed it sufficient for all necessary purposes. I did not press her to continue the treatment, as I thought it highly probable the effect upon the nutrition of her mucous membranes originated by Electrolysis would go on unassisted, as I have frequently seen to be the case.

Thickening of the membrane lining the posterior nares is a common accompaniment of mucous deafness; so also is an enlarged condition of the tonsils, which has given rise to the name of Throat Deafness.

Examples could be adduced to show the effect of Electrolysis in reducing the size of the tonsils, lessening the mucous thickening in the posterior nares, and opening up permanently the channel of the Eustachian tube; but the following case may be taken as an average one:—

Case IX.—S. P., æt. thirty-seven, had been subject for many years to repeated attacks of quinsy. His tonsils had been excised to cure him of this disease, and he was now very liable to severe colds in his head and throat. Since the operation on his tonsils, he was partially deaf in both ears at all times, and became entirely so on every recurrence of catarrh. I saw him in the winter of 1869, when just recovered from a severe attack of influenza.

His ears on examination were found full of wax, but its removal did not relieve him in the least. On testing the condition of the Eustachian tubes, I found they were nearly closed, and there was considerable thickening of the mucous membrane where it passed out of the posterior nares.

As his general health was much impaired, I paid some attention to his constitutional symptoms, giving him alteratives and tonics. For the state of his ears I passed a small sponge attached to a negative electrode through his nostrils, and placed the positive electrode behind the soft palate, using a power of five cells. Six such applications removed the thickened mucous membrane. For the impacted Eustachian tube a small gold catheter, insulated except at the point, was attached to the negative pole of a battery of ten cells, and pressed into its throat orifice, circuit being made by a positive electrode placed in the external meatus (previously filled with tepid water). The current was allowed to pass for three minutes. This was done with both ears, and had not to be repeated, as the one application removed the obstruction. No pain or unpleasantness of any kind followed the operation, and the patient's hearing continues good to this time.

Case X.—*February 9th,* 1870.—F. E., æt. forty-eight years. Deaf in left ear for the past five years. The hearing of the right ear is very good; but the left is so deaf he cannot hear his watch when placed against it, nor the voice beyond six inches (the right ear being plugged). Left Eustachian tube impervious, membrane of the left drum very much pressed inwards. Frequent and forcible efforts with the Politzer bag make no impression on the tube. The calibre of it must therefore be almost obliterated by thickening of its lining membrane. I passed a gentle current of ten cells along the course of the tube, with voltaic alternatives, for five minutes daily, applying the Politzer bag six times after each sitting. This treatment was proceeded with for a fortnight, by which time the tube was so relaxed as to admit air freely, and the hearing had returned to the extent of hearing the watch tick at three inches and the voice at two feet. The position of the drum-head was also much improved. Examination with the otoscope disclosed the presence of mucus in the middle ear, and it was evident no further improvement could take place till that was removed. The alteration in the position of the drum-head showed that there were no adhesions on its inner surface, and the case might thus be looked on as very hopeful.

March 1st.—I injected into the cavity of the drum a warm weak solution of hydrochlorate of ammonia, and passed a current of five cells, gradually increased to fifteen, for ten minutes, through it. This treatment was repeated every second day to the sixteenth, when I considered it advisable to stop for a week or ten days to see the result.

April 1st.—No treatment has been pursued since the sixteenth ultimo. Air enters freely into the cavity of the drum, the capacity of which is evidently increased; the membrane of the drum is more mobile and moves forward naturally, showing a well-formed luminous spot when the patient inflates the ear in the Valsalvian manner. The hearing is much improved. The watch can be heard without an effort at three feet, the voice at fifteen feet. There is still a little mucus in the middle ear; but, as the Electrolysis has improved the condition of its lining membranes and restored the activity of its absorbents, I consider the case now requires but slight assistance. I advised the patient to inject a little warm water once a week for two months into the cavity, and abandon all other treatment.

July 10th, 1871.—I have had an opportunity of seeing F. E. to-day. His hearing continued to improve for some months after he stopped treatment, and is now at what he considers his natural standard.

The following case of mucous accumulation in the cavities of both drums, with thickening of the mucous membranes generally, is noteworthy, not only from the almost total deafness which its removal cured, but also from the shortness of the time occupied in the treatment :—

Case XI.—*March* 21*st*, 1871.—L. J., æt. twenty-nine years, has been deaf in both ears since the spring of 1865. He had previously been subject to severe attacks of influenza, and considers his deafness arose from exposure to severe cold while travelling in the north of England during an attack. His inability to hear has increased gradually. At present he cannot hear the watch tick when pressed against his ear, and understands the voice with difficulty at one foot from him. The lining of his nostrils and throat is much thickened, and he speaks with a strong nasal twang. Air enters slightly through both tubes to the middle ear, producing a mucous râle; the membrane of the drum on each side is mobile, with slight displacement. His deafness is evidently due to accumulations of mucus in both cavities, combined with a generally thickened and unhealthy state of the Eustachian and naso-pharyngeal mucous membranes. To lessen the thickening and induce a more healthy condition in these membranes, and as a preliminary to dealing with the contents of the cavities, I passed a current of fifteen cells over the mucous linings of the throat and nostrils for ten minutes; this was repeated daily for a week, by which time a free discharge of tough, glairy mucus was set up, and the membranes themselves were assuming a more healthy character.

March 30*th*.—I was enabled to inject both cavities with a solution of carbonate of soda, and employ a current of eight cells for five minutes to each ear. The injection to be repeated three times a week, and the current to be applied daily. The patient, in addition to this treatment, to draw up through the nostrils to the back of the throat, and previously to spitting it out gargle with it there a moderately strong solution of hydrochlorate of ammonia in glycerine and rose-water. This course was pursued for a month, when I considered it judicious to stop for a fortnight, to enable me to check off the progress made after the electric stimulus was withdrawn.

April 14*th*.—With the right ear he now hears the watch at twelve feet, the voice at twenty-five feet. With the left ear scarcely half these distances. The lining of the nostrils and throat is healthy, and the nasal tones very much improved. The use of the solution of hydrochlorate to be discontinued, and treatment directed entirely to the left ear.

May 1*st*.—Right ear continues as last reported; left ear so much improved it is not considered necessary to continue treatment.

A thickened state of the lining of the drum, with rigidity of the membrana tympani and probable anchylosis of the joints of the small chain of bones which conveys the vibrations of sound to the auditory nerve, is the worst, and under ordinary treatment the most hopeless form of mucous deafness.

The two following cases, occurring in my practice, incline me to hope that the electro-therapeutic treatment, if persevered in long enough, will usually restore some measure of hearing:—

Case XII.—E. M., æt. thirty-two years, has been extremely deaf in both years since the age of twenty. He cannot now distinguish the ticks of the watch when held close to his ear, nor the vibrations of the tuning-fork unless the instrument is placed in the meatus itself. The voice can be heard with difficulty close to the ear. Examination discloses a condition similar to the description above. He has been under treatment at various times, and has repeatedly injected the middle ear with various medicated solutions, but without any benefit whatever. On the 9th August, 1870, I injected the cavities of both drums with a solution of iodide of potass, and passed a current of ten cells, increased to twenty, for fifteen minutes through each ear. This was repeated thrice a week for upwards of two months, when the treatment was stopped for a fortnight and resumed in the early part of the following November. I then injected each cavity with a solution of chloride of sodium, and applied the current, as before, three times weekly for a month. His hearing had now somewhat improved, especially in the left ear, with which he could hear his watch at an inch and a half, and the voice at nearly two feet. I now allowed him to continue the treatment himself, advising a month's treatment alternating with a fortnight's rest, to be continued under my occasional supervision for at least six months longer.

July 5th, 1871.—E. M. has been steadily persevering with the electro-therapeutic treatment till this date. His right ear manifests no increased improvement, but the left continued to improve gradually until the middle of May, since which time it has remained stationary; with it he can hear his watch at three feet, and follow a conversation with ease, for about half-an-hour, at five feet; after that time the hearing becomes somewhat dull, as if fatigued. When rested, the power returns to the same extent. No improvement having taken place for the last six weeks, I advised suspension of treatment, believing that the present measure of hearing will be retained.

Case XIII.—R. B., æt. forty-nine years, widow of a naval surgeon; deaf in both ears since her last confinement—about twelve years ago. The symptoms were much the same as in the previous case, and evidently from the same cause. On the 9th August, 1870, I commenced the same treatment, and pursued it much in the same manner as in that case; early in November, 1870 (the treatment was stopped at that time), she heard the voice without much effort at three feet six inches, but could not hear the watch tick although held close to her head. Her ears, as she expressed it, were "brighter." She had lost the sensation of dulness and weight in them which had troubled her so much, and the noises which formerly were always present, came now only at long intervals. The improvement was equal in both ears.

A larger experience of this method of treatment in complete deafness is necessary before its true value can be ascertained, but the success attending it in the two cases just reported is sufficiently marked to warrant us in trying it, even in the apparently most hopeless.

Many persons who have resided in hot climates become deaf after attacks of the special fevers of the countries they inhabited; or, on their return to Europe, from repeated catarrhs before they became acclimatised.

Case XIV. *March*, 1871.—A. M. B., æt. forty-six, retired Indian officer, became deaf in both ears after an attack of jungle-fever, in 1863. The loss of hearing was very gradual, but is now so great he cannot take part in any general conversation. The sounds of his watch are lost at one inch, the voice at four inches. He is also much troubled with sounds in the head, but cannot say whether they are in the ears or diffused over the head; his sense of smell is also defective. Had to abandon his profession in consequence of his deafness, and has been in England for three years. An examination disclosed a very narrowed and almost closed condition of the Eustachian tube and cavity of the drum on each side, owing to a highly-thickened state of the lining membrane, the result of chronic mucous inflammation. Any chance of improvement would therefore lie in the ability to reduce the thickening and increase the capacities of both Eustachian tube and middle ear. A daily course of electrolysis for a month entirely altered the condition of the mucous membrane, and set up such a healthy action in it that the patient was enabled to inflate the cavity of the drum without difficulty, by merely holding the nostrils, closing the mouth, and gently blowing. Finding the tubes now open, I injected a solution of iodide of potass into each middle ear thrice a week for a month, and immediately after each injection passed a tolerably strong current through both ears for ten minutes each time; at the expiration of the second month the hearing had improved, so that he could understand a conversation held at four feet from him, and note his watch-ticks at eleven inches.

His remaining in town any longer was most inconvenient to him, and I allowed him to return to his house in the south of England, having first laid down a plan of electrolytic treatment for him and instructed him how to perform it. I have heard from him as late as October, 1871; he was then persevering with the treatment, occasionally discontinuing for a fortnight and then returning to it. His hearing was so much improved he considered further treatment unnecessary.

CASE XV. *March,* 1871.—S. V., æt. thirty-five, widow of an Indian officer, and a resident in India from her seventeenth year until three years ago, when, in consequence of her husband's death, she returned to England. Shortly after her arrival she had a severe attack of epidemic influenza, which left her partially deaf in both ears; this condition has increased, and she now can hear only with very great difficulty.

The right ear is much worse than the left; with it she can hear the watch tick if placed close to it, and the human voice at about six inches. The left ear is comparatively good, as she can count her watch-ticks eight inches, and follow the voice at two feet. She complains of great noises in both ears, very much increased by anything which startles her, or by fatigue.

An examination disclosed the condition usually found in such cases—Eustachian tubes nearly if not entirely closed, cavities of the drums filled with mucus, and the aural mucous membrane throughout its entire course unhealthy, thickened, and congested.

I placed her under a course of electrolysis, which was persevered with daily for some time; after the first three weeks I was enabled to pass a solution of hydrochlorate of ammonia down each Eustachian tube into the cavities of the drums. On this the current was played, and with excellent results. Within two months from commencement of treatment the condition of the membrane was much improved, air entered both cavities freely, the membrane of each drum had recovered a considerable amount of mobility, and the hearing had returned so that she could hear the voice, on either side, a distance of six feet, and the watch a little over two feet.

From this time until the end of August she followed up the treatment herself, with slight supervision on my part. When she left town her hearing powers were then nearly fully restored.

The following case is somewhat similar to the last, especially as regards the noises in the head, although the causes which produced the symptoms were different.

CASE XVI. *January* 12*th*, 1871.—J. C., æt. forty-seven years, member of the American Congress. Deaf in right ear, and partially so in left. Membrane of right tympanum very much thickened and pressed in, right Eustachian tube entirely closed; is unable to hear the watch tick or the vibrations of the tuning-fork when held close to the outer ear. On the left side the membrane of the tympanum is also thickened and somewhat displaced. The Eustachian tube is open, but only partially so: can hear the watch tick at one inch from ear, tuning-fork at eighteen inches; ordinary voice, if enunciation is distinct, at twelve inches. In both ears he has distressing noises, but cannot say which is worst, as they vary.

Hearing in right ear began to diminish without any known cause in the autumn of 1860, and gradually lessened until about three years since, when it entirely left. The left ear has been passing into the same condition for the last five years, and he fears will go like the other.

As some measure of hearing existed in the left ear, I decided on devoting my attention at first to the right ear only. With this view I placed him at once under the electrolytic influence, applying mild currents with voltaic alternatives along the track of the Eustachian tube on that side. A fortnight's treatment was sufficient to relax its mucous lining sufficiently to allow inflation of the middle ear, and consequent ability to fill it with fluid. On the 27th January I injected the cavity with a weak alkaline solution, and immediately afterwards applied the current for ten minutes; this was repeated every alternate day till the early part of March, when his hearing was so much improved it was considered judicious to arrest the treatment for a period. He left town for a month, and, on his return in April, I had an opportunity of noting how the improvement, originated by the electrolysis, continued after its employment was stopped. The whole of the conducting apparatus, which had been at fault, was returning to a healthy condition; he could converse with ease at twelve feet, and hear the watch tick at four feet. As he was about to return to America, I advised him to suspend all treatment for the other ear until his arrival there, when he could himself pursue the plan laid down for him, the method of carrying out which I instructed him in.

One of the most annoying causes of deafness is accumulation of thick, hardened, unhealthy wax in the outer ear, so far up the passage as to press against the drum and intercept the sonorous vibrations from without. When the quantity is great, the consistence hard and dry, and the pressure considerable, very unpleasant symptoms accompany it, such as severe pain in the ear, giddiness in the head, and loud and distracting noises.

Many cases yield to ordinary syringing with warm water, but are liable to relapses, as the unhealthy state of the wax-forming glands which produced the abnormal accumulation may still be present. In other cases the wax is so dry and hard, and so firmly attached to the membrane of the drum, that no available force can remove, nor any ordinary remedy dissolve it. The disintegrating effect of electrolysis rapidly detaches it, and breaks it down so as to allow of its being washed out by a stream of water, as the following illustrates :—

CASE XVII.—M. M., æt. forty, clerk in a City bank, in the latter part of December, 1870, while sponging his head with cold water, pressed some of it into his right ear; he was immediately seized with intense pain, which continued for some hours, and yielded at last to hot fomentations. Since then he complained of great weight and pain, and has been very dull in that ear, and much troubled with noises which interfere most materially with his business pursuits. Drops of various kinds have been put in the ear, and it has been frequently and forcibly syringed, but no wax has come away, nor has any relief of the unpleasant symptoms been obtained by this treatment.

March 9th, 1871.—Examination of the ear with the auroscope disclosed a dry, rough, black mass closing up the passage, and entirely obscuring the view of the membrane of the drum. It was evidently an accumulation of wax, so hard as to resist the ordinary solvents and injections used. I filled the passage with warm water, retaining it there with a piece of sponge, to which I applied the negative pole of a fifteen-cell battery for five minutes, completing the circuit by placing the positive pole in the other ear. On removing these I injected the passage with a gentle stream of warm water from a four-ounce syringe. This brought away a great quantity of hard, black, irregular-shaped wax. The relief was instantaneous, and all the unpleasant symptoms at once subsided. On again examining the ear I found the passage clear, and could see the drum-head, somewhat congested from the long-continued pressure. He has had no return of the symptoms.

Similar cases, although produced in very different ways, are very common; but they invariably yield to the same course of treatment.

Deafness frequently occurs in persons in whom the most careful examination cannot detect any malformation or disease in the mechanism of the ear. These are essentially cases of nervous deafness; and if the history of the case points to the cause arising from shock, fright, hysteria, &c., or is the result of excessive fatigue, long-continued exposure, anxiety of mind, or comes on with the exhaustion consequent on excessive drains on the system, over-suckling, severe and protracted illnesses, &c., &c., it may be considered as curable.

Dr. Moos,* of Heidelberg, relates a most interesting case of hysterical nervous deafness cured by the electric treatment, and one of complete deafness following an attack of cerebro-spinal meningitis, in which the hearing was so far restored after twenty-two applications that the patient could hear well at twenty-two paces.

The following two cases, occurring in my own practice, are interesting, as showing the power of the continuous current over the conditions just described:—

Case XVIII.—S. R., æt. twenty-eight, a lady of a highly nervous temperament, was very much broken in health in consequence of grief and fatigue. She had nursed a favourite and only sister during a long illness, which had ended fatally, and had lately become totally unable to distinguish articulate sounds, even when spoken to loudly. She consulted me in March, 1870, and described the sensation thus:—When spoken to she could hear the sound of the voice, but could not make out the words, the whole being a mere continuous noise. She had no other symptom pointing to the condition of her ears, and careful examination of them failed to throw any light on the cause of her deafness.

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* Archives of Ophthalmology and Otology, Vol. I., No. 1, p. 332.

Her general condition and the history of the case indicated with tolerable accuracy the cause. I at once applied a current of twenty cells to both ears, and continued to do so daily for ten days. I then increased the power to thirty cells, which was applied every alternate day until the middle of May, by which time her hearing was so far re-established that I advised the treatment to be stopped, and the patient to go to the sea-coast for at least three months. This was done, and I had the satisfaction of seeing her in town early in September, 1870, with her hearing perfectly restored, and her general health very much improved.

CASE XIX. *Deafness from fright—paralysis of the auditory nerve.*—F. D., æt. twenty-nine years, a married lady, accompanied her husband in a yachting excursion in August, 1870. Owing to very rough weather the boat was capsized, and they were in great danger of drowning. They were brought ashore by a boat from one of the light-ships on the coast, and soon recovered the general effects of their wetting; but it was discovered the lady was quite deaf. She continued in this state till the 29th September, when I first saw her. Examination of her ears disclosed a perfectly healthy condition, but the history of the case was sufficient evidence of the cause of her deafness. I passed a mild current through both ears for five minutes, and repeated it daily for three minutes. At the end of ten days she had entirely recovered her hearing, and treatment was discontinued.

Similar cases of deafness from paralysis of the auditory nerve might be adduced where a short treatment has completely restored the lost faculty. This form of deafness is produced by any cause which gives an unexpected shock to the nervous system. A box on the ear has produced it, without any injury to the drums. The explosion of a cannon, the sound of a steam-whistle, the upsetting of a carriage, a railway collision, a fall into deep water, have each produced this variety of deafness. Generally speaking, a very short course of treatment restores the hearing, although in very aggravated cases a long-continued course even has been unsuccessful.

DEAFNESS IN OLD AGE.

In the aged deafness may arise from the same causes which produce it in the young and in the adult; but it also may arise from degeneration of tissue in the various parts of the ear, or from rigidity in the joints of the ossicles, so that sonorous vibrations from the drum are intercepted or imperfectly conveyed to the auditory nerve. Either or both these causes combined will produce a very serious degree of deafness.

Deafness from degeneration of the molecules of the auditory nerve-filaments, or of its trunk, may be reckoned as hopeless, but that arising from the other causes mentioned is open to a certain measure of improvement. A greater or less degree of rigidity in the membrane of the drum and in the joints of the ossicles is the natural consequence of an advanced period of life, and treatment can have no satisfactory result if not specially directed against this condition. Stricture of the Eustachian tubes is also a fertile source of deafness in the aged, and when not accompanied by the other conditions just mentioned is capable of great improvement, as the following case will show:—

Case XX. *Jan.* 14*th*, 1870.—J. E. J., æt. seventy-four years, formerly in the Army, has been partially deaf in both ears for the past ten years, but has lately become completely so. He was formerly subject to severe attacks of cold in the head, but has not had them latterly. His general health is excellent, but his extreme deafness is a source of much distress, as it cuts off all intercourse with his circle of friends. The Eustachian tubes in both ears have been strictured for more than six years, and he has had a catheter passed at various times with considerable temporary benefit. Until twelve months ago he employed Politzer's bag daily to keep the tubes open, but desisted then, as he was unable to force any air into either ear. I passed a stilette with considerable difficulty through the left tube, and while it was there, applied a power of ten cells to it, placing the positive pole in the external ear of the same side, and converting the stilette into a negative pole: the electrolysis was kept up for five minutes, and on the withdrawal of the instrument the hearing immediately returned to such an extent that he could count the watch-ticks at three feet, and hear an ordinary voice at five feet. At his period of life, this was satisfactory to him. Five days afterwards I operated in a similar manner, and with a like result, on the other tube. Upwards of a year has passed since these operations, and I have had many opportunities of conversing with him. His hearing continues unabated, air entering freely into both cavities through the tubes.

The electrolytic action caused absorption of the obstructing matter, hence there was no relapse. Mere dilatation in the ordinary manner would not have prevented a return of the mischief when the effect of the stretching wore off. Had he been a much younger man, with a more vascular mucous membrane, I make no doubt his hearing would have risen to the full standard.

The following case fairly represents the measure of improvement which may be reasonably expected from the electro-therapeutic treatment when much rigidity and dryness exist in the outer and middle ear:—

CASE XXI.—F. S. C., æt. sixty-nine years, retired surgeon, enjoys excellent health, but is so extremely deaf in both ears that he has been compelled to retire from practice. Cannot hear a watch tick when pressed against either ear, nor understand the voice unless when spoken to in a very high key, close to his ear. He is very much troubled with noises in his head, which are so much increased by travelling in a carriage, that he has to confine himself as much as possible to walking. Examination shows that both auditory nerves are sound; the Eustachian tubes also are open, and the cavities of the drums filled with air, but both drum-heads are hard and immovable, and do not change position in the least when the drums are inflated from within. When he blows in the Valsalvian manner the otoscope discloses a dry harsh sound in the middle ear. The cause of deafness evidently depends on this dry, rigid state.

September 19th, 1870.—I injected both cavities with a mixture of carbonate of potash, glycerine, and water, and pressed a little air in immediately afterwards with Politzer's bag, that the solution might be effectually distributed over the roof of the cavities and the joints of the ossicles. A current of ten cells was then passed through both ears for five minutes each. This course was pursued twice a week for a month. After the earlier operations he complained of weight and increased noise and dulness in both ears; these sensations were troublesome at first, but as absorption became more rapid under the electric influence, they soon passed off and did not return during the subsequent treatment.

October 20th. — Hearing slightly improved, noises in the head much lessened, *believes* he hears his watch tick, but is not quite certain; can hear the voice in a moderate key at eighteen inches. The treatment was pursued in the same manner till the end of the year; he then could follow a conversation across a table with ease and without fatigue, and the noises were quite gone.

The measure of hearing thus attained has continued. He occasionally returns to the treatment for a very short period, as he fears the rigidity may return. One peculiarity in the case is that his power of hearing his watch tick has not increased in the same proportion as his ability to hear the voice.

Case XXII.—A.M., æt. sixty-three years, a lady of spare habit and weak circulation, has been gradually becoming deaf for some years past. She consulted me in December, 1869. After applying various tests to satisfy myself as to the cause of her deafness, I came to the conclusion that innutrition of the auditory nerve-filaments was the most likely. I passed a very gentle continuous current through the whole hearing apparatus from the outer ear to the throat entrance of the Eustachian tube. The action was kept up for five minutes, and repeated three times a week for two months, by which time her hearing was sufficiently restored to enable her to take part in an ordinary conversation without much effort. Since then she has had on four occasions a slight return of the deafness, which is always removed by a few repetitions of the operation. From the history of this case it is evident the deficient circulation in the nerve-substance depends on some feeble condition of the minute vessels, which require the occasional stimulus of the electric current to give them vigour. This lady will always be liable to a return of her deafness; but the periodical application of the continuous current will ward off the attack.

Case XXIII.—J. L., æt. sixty-two, wife of a medical man, had been subject for many years to most distressing noises in the head, which rendered her existence perfectly miserable to her. Owing to her husband's position, she had opportunities of consulting the most eminent professional men of the day, including aurists in London and Paris. Having received no benefit from treatment, she had some hesitation in allowing me to employ any new means for her relief, but, after a little solicitation, permitted me to pass a gentle continuous current through the ear, placing one electrode on the mastoid process and the other in the back of the throat. The first application made her very giddy; in the next, I applied the pole to the outer ear, instead of the mastoid process, and no unpleasant result followed this method. The treatment was pursued steadily for two months, during which time the current was occasionally applied to the cervical sympathetic. She felt so much relieved at the expiration of this time that she wished the applications continued; but I suggested their suspension, as I believed the influence having been made upon the nerves, the effect would continue without further operation. The result turned out as I expected. The noises gradually subsided; and in about fifteen weeks from the time I first applied the remedy she was quite free from her old enemy.

One curious circumstance in this case was the change which took place in the character of the noises as the influence of the current began to assert itself. The sounds were described at first as loud and hissing, alternating with dull, heavy noises, as if some heavy body had suddenly fallen; these were succeeded by sounds as of church bells, or loud voices in the distance, and these gradually passed into sensations of a general confusion of sounds as of a great many persons speaking at once. These last passed quietly away, and eventually left her free from all.

Dr. Brenner, of St. Petersburg, has reported cases of Tinnitus Aurium treated successfully by the method detailed in the foregoing, as well as others which resisted treatment. Drs. Beard and Rockwell, of New York, obtained a perfect cure in one marked instance, by galvanisation of the sympathetic nerve, and Dr. Benedikt, of Vienna, has also been successful in several cases in which he applied the same treatment.

The pressure of thin, hard, dry cakes of wax against the membrane of the drum often gives rise to severe noises in the head, giddiness, and other disagreeable symptoms, without deafness. These cases are often very alarming to the patient, but are easily remedied by removing the cause. A good example of this ailment may be found in

CASE XXIV. *April 12th,* 1870.—M. H. W., æt. thirty-two years, consulted me for what he described as "a horrible and painful tumult" in the left ear. It had gradually increased since its first appearance, two years ago, and was now so severe that, as he expressed it, if it came into the other ear, also, "he must lose his senses." Blistering, syringing, &c., &c., had been employed almost since the commencement, but had not relieved him. On examining the ear, I found the membrane of the drum covered by a dense hard substance which kept it entirely from view. On this I injected streams of warm soap and water to remove it, but without any effect. I then filled the outer meatus with a weak solution of carbonate of soda and water, and applied a current of fifteen cells to it for five minutes. This was immediately followed by fresh syringing, which at once brought away a thin plate of hard, dark brown wax, the removal of which at once disclosed the drum-head. The symptoms, though somewhat relieved, did not immediately subside. The electrolytic treatment, without the syringing, was continued daily for a week; by that time the sounds had subsided to a gentle singing noise. Treatment was then stopped.

A month later I again saw this gentleman; the sounds were entirely gone and the ear otherwise was healthy. Many such cases come under treatment, and always with good results. There is no doubt, however, that in many instances where the causes are more obscure a long course of treatment is necessary, and even that does not always end in success. In one case under my care, occurring in an elderly widow lady, the treatment was continued for nearly three months before relief was obtained.

The following cases are not ranged under any particular head, and are interesting from the fact that they had in each instance been subjected from time to time to the usual routine treatment at the hands of various aurists, engaged in both public and private practice, without any appreciable benefit.

CASE XXV.—*October 28th*, 1871.—E. J., æt. twenty-nine years. Engaged in the household of the Duchess of ——. Deaf eight years in left, and six years in right ear. Has been subject to repeated attacks of catarrh since boyhood, and dates his deafness from the time he received a severe wetting.

Examination.—Right ear: Hearing distance—watch, thirty inches; voice, four feet. Cone of light large, broken and diffused; membrane of tympanum mobile; Eustachian tube pervious; auditory nerve healthy. The Valsalvian experiment discloses a small, soft, mucous râle.

Diagnosis: Accumulation of thickened mucus in cavity of tympanum, and diminution of its capacity from thickening.

Left ear: Hearing distance for watch and voice, eighteen inches; cone of light contracted to a minute point, where apex should be; membrana tympani immobile; Eustachian tube impervious; no sound in the cavity during the Valsalvian experiment; tuning-fork heard equally well on either side of head.

Diagnosis: Complete closure of Eustachian tube, malposition of head of drum from atmospheric pressure,* and also perhaps from adhesions. No means of obtaining further knowledge of condition of cavity and contents, until the Eustachian is fully opened.

Treatment.—Right ear: Pass a current of five cells for three minutes through cavity of tympanum (having previously injected it with sol. sod. carb.), and repeat every alternate day for the present.

Left ear: Pass a current of ten cells for five minutes from throat-opening of Eustachian tube to outer meatus, and immediately after apply Politzer bag; repeat daily.

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* *Vide* page 21.

20*th November*.—Treatment, as above, continued till this date. Right ear much benefited; left ear not improved.

In consequence of a severe catarrhal attack, treatment to be suspended for the present.

December 11*th*.—Treatment resumed; three times a week.

January 15*th*, 1872.—Improvement has been so marked of late that the patient considers his right ear quite restored, and his left as good as it was three years since.

Examination.—Right ear: Watch tick, ten feet; voice, forty feet. General appearance of membrana tympani, healthy; cone of light clear and well defined.

Left ear: Watch tick, eighteen inches; voice, four feet. The Eustachian tube is open, and the cavity receives air; but there is evidently considerable thickening of its lining membrane, and rigidity of membrana tympani. Confine treatment to left ear only; and with a view to relieve the thickened lining, inject cavity of drum with sol. pot. iod., and pass a current of fifteen cells through it for five minutes twice a week.

March 15*th*.—The treatment of left ear has been continued till this date. Still somewhat duller than right, although much improved. The hearing distance is now, for the watch, eight feet; numerals twenty feet; voice, twelve feet.

As absorption is going on steadily, and the thickened lining is returning to a healthy state, I advise all treatment, beyond the daily inflation of the cavity, to be stopped, as I doubt not the absorbents are sufficiently active to complete the restoration unassisted.

CASE XXVI.—*December 28th,* 1871.—Mr. B., æt. fifty years, clerk in Somerset House; deafness commenced twelve years ago in both ears, and is now so great he fears he must resign his appointment in consequence.

Examination.—Right ear: Hearing distance—watch, one and half inch; voice, two feet. Membrana tympani yellowish grey, mobile but sluggish; cone of light irregular and dull; cavity of tympanum partially filled with mucus; Eustachian tube open.

Left ear: Much the same as right. Tuning-fork heard equally well on either side of head.

He has been subject for many years to attacks of catarrh, coming on suddenly and leaving as suddenly. Is of a somewhat nervo-excitable temperament. The duties of his department detain him late in his office, which is overheated and gas-lit. He is accustomed to hurry off from it to catch a late train to convey him to his residence, some distance from town, and attributes his deafness to a long continuance of this habit.

The membrane lining the nostrils, upper surface of soft palate and throat, is thickened and congested; voice somewhat nasal; senses of taste and smell considerably impaired.

Diagnosis: Mucous deafness commencing in the throat, and extending along the Eustachian tubes into the cavities; mucous accumulation and probable adhesions, with thickening.

Treatment.—For the generally thickened and unhealthy state of the naso-aural membrane in its whole course, two ounces of a mixture of glycerine, sesquicarbonate of soda, and camphor-water are to be sniffed up the nostrils, passed over the upper surface of soft palate and drawn and discharged through the mouth, three times daily. This will have the effect of dissolving and cleansing out all mucous accumulations along its course, and setting up a healthier action in the membrane.

For the ears: Both to be injected with a weak solution of hydrochlorate of ammonia every second day, a current of five cells to be passed through both ears daily, and inflation of both cavities to be induced directly afterwards.

March 15th, 1872.—The above treatment was continued daily for the first week, then every alternate day for the next fortnight, and from that time till the 13th February twice a week; since then, once a week until to-day, when it is to cease, not being required longer. His hearing distance is now fifteen feet with each ear; he can follow and take part in all conversations in his family or his office; and it is probable his range of hearing may still further increase without treatment, as his absorbents are active.

CASE XXVII. *February* 9*th*, 1872.—Mrs. ——, æt. sixty years, member of the Society of Friends. Hearing impaired for upwards of twenty years, and of late has become rapidly worse.

Examination.—Right ear: Impaired for at least twenty years. Hearing distance—watch, one inch; conversation twenty-seven inches. Cone of light broken; membrana tympani extremely concave and immobile; Eustachian tube closed; auditory nerve sound; great noises in the ear.

Diagnosis: Great diminution of capacity in the tympanum. The closure of the Eustachian tube may be the cause of this and of the extreme malposition of the membrana tympani, but adhesions within the cavity and dislocation and anchylosis of the ossicular chain are to be feared. The tinnitus may arise from pressure.*

Left ear: Impaired for twenty years, but not to same extent as right. Could follow a conversation held near her with a little effort, until about six months since, when extreme dulness came on, and it is now much worse than the other ear.

Hearing distance: Watch heard when closely pressed against the ear. Conversation at nine inches. Membrana tympani presents a singular appearance, as if covered with semi-transparent, amber-coloured, irregular-shaped cells, from the more prominent portions of which small points of light are reflected; the position of the membrane cannot be ascertained. Eustachian tube open and mucus disclosed in cavity of tympanum on applying the Valsalvian experiment; auditory nerve sound.

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* *Vide* page 41.

This lady has been subject since the middle period of life to frequent attacks of catarrh; she attributes the extreme deafness in left side to a cold caught about six months since.

Treatment.—Right ear: Pass a current of five cells daily along the course of the Eustachian tube, and immediately afterwards apply Politzer bag for five minutes, using suction tube to the outer meatus at same time. Desire her to blow in the Valsalvian manner three times a day for two minutes, and have the suction tube applied by some friend at the same time. Also, in all occasions of swallowing fluid, to hold the nostrils and prevent the escape of air.

Left ear: To determine the character of the appearance seen on the membrana tympani, the outer meatus was washed out with tepid water; this effaced it, but on the following day when the membrane was dry, the reticulated appearance and luminous points returned, owing evidently to partial desquamation of the dermoid layer of the membrana tympani. Inflating the cavity forcibly produced no movement in the membrane, but disclosed a mucous râle.

Diagnosis: Desquamation of dermoid layer and malposition of membrana tympani from adhesions, diminished capacity of cavity and accumulation of mucus in it. The latter most likely the result of the recent catarrhal attack, and the cause of sudden increase of deafness.

Treatment for the Desquamation.—Two drops of glycerine dropped into external meatus every second night at bedtime, and the passage gently syringed with tepid water the following morning. For the mucous accumulation, adhesions, &c., inject the cavity with a weak solution of sesquicarbonate of soda, and pass through it a current of five cells for five minutes every second day. The patient to blow daily in the Valsalvian manner for five minutes simultaneously with the application of the suction tube.

March 15*th.*—Treatment continued till this date. *The right* Eustachian tube was fully opened by the 25th February, when the position of the membrana tympani was much improved and the tinnitus ceased. No mucus was discovered in the cavity. The hearing distance is now for the watch, one foot; conversation, nine feet with ease. The left ear has improved in even a greater degree. The membrana tympani has lost the luminous appearance, and is now a bluish pearly grey; its position is much improved. The mucus râle is absent, showing that the accumulation in the cavity is absorbed. Hearing distance—watch, one inch; conversation in a low voice, twelve feet. On Sunday last she was enabled to follow her preacher at about forty feet distance. This must be looked on as an unusually favourable result in so short a time.

General treatment to stop, but the middle ears to be inflated at least once a day by the Politzer bag.

April 3rd.—Mrs. —— still continues as well as last reported; uses the Politzer bag as directed, and recommended to continue to do so.

CASE XXVIII. *March 9th,* 1872.—Master P., æt. seventeen years, son of a gentleman connected with one of the morning papers, had scarlatina in his ninth year, with ulcerated throat, and has been very deaf ever since. Never had purulent discharge from either ear; speaks with a strong nasal twang; submaxillary glands chronically enlarged; has had both tonsils excised.

Examination.—Right ear: Hearing distance—watch, one inch; voice, two feet. Membrana tympani immobile and of a pale ash-grey colour, with dirty yellow streaks; cone of light reduced to a fine point about the umbo; Eustachian tube entirely closed; auditory nerve sound.

Left ear: Hearing distance—watch, two and a half inches; voice, three and a half feet. Eustachian tube very partially open; membrana tympani immobile, and much the same colour and appearance as the right, except that there is a broken wave of light passing over it downwards and inwards.

The nasal mucous membrane is dry, tender, and thickened, and in the right nostril the passage is closed.

Treatment: Apply current of five cells to each ear for three minutes daily, and use the Politzer bag immediately afterwards, with moderate force; for condition of thickened nasal membrane, a solution of biborate of soda in decoction of poppies, to be sniffed up the open nostril and discharged through the mouth three times a day. A piece of sponge soaked in a solution of nitrate of silver to be pressed into the closed nostril, as far as the point of resistance, once daily.

April 16*th*.—Treatment continued with a slight interruption until this date. On the 15th March the Eustachian tubes yielded to the combined action of the current and the Politzer bag, and air entered freely into both cavities; since then, improvement has been great. The aural mucous membrane is much healthier, and the right nostril admits the passage of a large-sized catheter without difficulty or pain. The voice is less nasal.

Hearing distance: Right ear—watch, eight inches; conversation, fifteen feet. Left ear—watch, nine inches; conversation, seven feet.

It will be observed that the improvement here is much greater on the right than left side, although the former was originally the more defective. I attribute this to a relaxed state of the left membrana tympani, which disables it from receiving the sonorous waves and vibrating as freely as it should. This I hope to overcome by the occasional application of a solution of tannic acid in glycerine to its outer surface. This and the occasional use of the Politzer bag, with attention to general health, is all that is now required. At this patient's age, with his absorbents active, and his tissues soft and pliable, the process of reparation, once set up as it has been by the electrolytic treatment, will go on unaided. It may be remarked in this case as in others, that the ability to hear the watch tick did not keep pace with the improvement in the power of hearing the voice. I cannot account for this fact, nor have I seen it noted by other observers.

Case XXIX.—*April* 10*th*, 1872.—C. E., æt. thirty-three years, late coachman in an English family in Paris; completely deaf in left ear for eight years.

Examination.—Hearing distance for watch and voice, *nil;* membrane of drum, dull pearly grey and convex; cone of light hazy and blurred, with base looking vertically downwards; Eustachian tube closed, and resisting all the usual methods of inflation. Is much troubled with noises in the head on left side. Auditory nerve healthy; naso-pharyngeal mucous membrane much thickened; voice rather nasal.

As all mechanical means to inflate the middle ear had been treated in Paris and here without success, I commenced at once to pass a current of ten cells from the back of throat to outer ear for ten minutes daily, and, after each seance, used Politzer's bag freely. No benefit was apparent from the treatment until the 2nd of May, when, after the current had been applied in the usual manner, the first application of the Politzer bag forced air through the tube into the cavity. The hearing distance at once rose to three and a half feet for watch, and twelve feet for the voice. The same treatment was continued until the hearing distance for watch and voice had reached fifteen feet.

During the progress of the electrolytic treatment, the patient drew up the nostrils, twice daily, about two ounces of a strong solution of soda, with considerable benefit to the thickened mucous membrane; he had pursued the same plan under other advice before coming to me, but without any advantage whatever. Its beneficial effect, when under my care, must have arisen from its employment along with the electricity. I have no doubt, from my experience of this and similar cases, that alkaline solutions in combination with electricity are rendered more active, and that the electric current itself is more effective from their use.

CASE XXX.—*July 22nd,* 1872.—E. P., æt. seventeen years, a native of Bampton, in Oxfordshire; a young woman, tall, and well developed for her age; lately apprenticed to a draper, but had to leave on account of her deafness. Deaf in right ear, six years; left ear, about eight years. The deafness came on gradually, but not as a sequence of any eruptive fever.

Examination.—Right ear: Hearing distance—watch, one inch; voice, two feet. Membrane of tympanum immobile, and of a brilliant pearl grey colour, with two small blister-looking prominences on it; cone broken and partly lost in one of these prominences; Eustachian tube slightly open; auditory nerve healthy.

Left ear: Hearing distance—watch, two feet; voice, four feet. Membrane of tympanum immobile, of a pale brownish grey colour, with badly defined, dullish cone of light; Eustachian tube partly opened; auditory nerve healthy; nasal mucous membrane somewhat thickened; throat healthy. Complains of total inability to hear a voice when her back is turned to the speaker.

A current of ten cells was passed for three minutes daily for a week, and the Politzer bag applied immediately after each application. The nasal douche was also used at home night and morning; on the 29th the tubes were found to be well opened, and the middle ears inflated easily. The hearing improved considerably at once, but the membranes of the tympani continued immovable; and I thought it advisable to change the continuous for the interrupted current, as it was more likely to act efficiently on the rigid membrane, especially if employed in conjunction with the suction tube.

August 21*st*.—The treatment has been steadily persevered in to this date with the following result. The membranes of the tympani move fairly on inflating the cavities, the general appearance is more natural, and they are at much better angles for receiving sonorous vibrations. The hearing is almost up to the natural standard.

Right ear: The voice is heard at twelve feet, the watch at seven feet.

Left ear: Voice perfectly distinguishable at twenty feet, watch at thirteen feet. She is also able to hear and carry on conversation at the same distance when her back is turned from the individuals speaking.

The treatment was now stopped, and she returned to the country.

In closing these reports, I may remark that while they represent a portion only of the cases successfully treated, I have had others which resisted all the curative means it was possible with our present knowledge to employ. These have usually been of such long standing and so inveterate a character, that success seemed hopeless from the first; but the general result of my experience leads me to believe that, with few exceptions, all cases of deafness arising from causes similar to those already stated will yield to the electrolytic treatment, if judiciously and patiently employed. For this reason I find the best course to pursue, when the case is so advanced as to evince steady improvement, is to allow the patient to perfect it himself. This, as a rule, he can easily accomplish, and *I would advise all medical men who may employ this* *method of treatment, to instruct their patients how to conduct it the moment they can be left to themselves;* by doing this, a fuller amount of time and attention will be given to the treatment than could be spared by the medical attendant, and in obstinate and long-continued cases there will be a greater certainty of success.

In this connection another well-established fact in electro-therapeutics may be mentioned—viz., that while "in the constant current we have a means more powerful than any other of modifying the nutritive conditions of parts that are deeply situated,"* still "these effects are often not developed until long after treatment has been abandoned. Weeks and months after a patient has undergone a course of treatment he may continue to improve, even though very little progress may have been made while the applications were being received."†

This fact, which applies to disease generally, is also of not less importance in its application to diseases of the ear.

In the use of a battery care should be taken to ascertain its power and to insure its steady working; very great disappointment often follows the use of inefficient instruments, and many cases of deafness treated by electricity have been abandoned as incurable because the means employed for generating the current were insufficient, or the knowledge of the operator too limited to apply it fairly. For the consulting room the most satisfactory battery will be found to be Daniell's or Stohrer's, while for the patient's own use a small one with ten cells on Foveaux's principle will be quite sufficient for all purposes.

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* Prof. Niemeyer. "Text Book of Practical Medicine," translated by Drs. Humphreys and Hackley. Vol. II., page 290.

† "A Practical Treatise on the Medical and Surgical Uses of Electricity," by Drs. Beard and Rockwell. New York, 1871. Page 148.

In self-application the patient must be cautioned against a powerful or long-applied current; experience proves that gentle streams used for a very short period, say from three to five minutes, exercise the most powerful and permanent alterative action on mucous membranes. Individuals can be over-dosed with electricity as readily as with wine, quinine, iron, or any other stimulant, alterative or tonic; and neglect of this caution may nullify the treatment, and, in some instances, produce giddiness or unpleasant nausea, and compel the suspension of the applications at the very turning point of the case.

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